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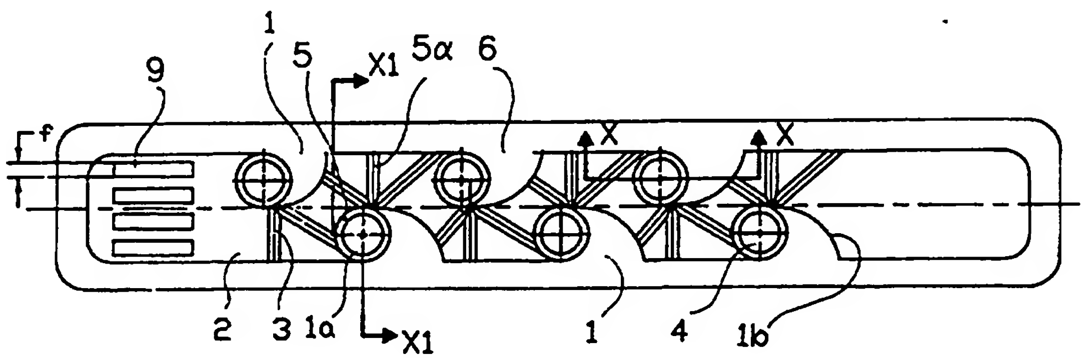

(57) Abstract

The invention refers to conventional emitters with a path for the water pressure drop which consists of repeated parts of a basic prismatic form (1) which is contained within convex (1b) and concave (1a), almost cylindrical in shape surfaces, at right angles to the base (2), which converge to a perpendicular edge (3). In the regions of the convave surfaces, cylindrical craters (4) are raised from the bottom, half way along the emitter height, forming hydrocyclones. Prismatic wedge-shaped forms (5) are also developed radially from the base along half of the emitter height. As far as the self-compensating emitters are concerned, our invention refers to an arrangement for water filtering at the inlet of the emitter which consists of an elastic membrane (24) which covers peripherally the mouths of a closed cavity (33) with radially engraved channels (18) of a small depth. Self-compensation is achieved in successive stages and in several cavities (31, 33) of the path by a combination of a couple of holes for the inlet and outlet of the water into the cavities and of a membrane. The membrane (24) balances at same height above all of the cavities and water paths which are arranged in series.

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New Emitter Unit Forms

The present invention refers to conventional and self compensating emitters suitable either for welding inside tubes or for independent placement on the tubes.

In existing systems, the flow of water in the flow restricting paths involves a motion of water in two dimensions: In the U.S. PAT. 4.215.822 the motion is between the rims of an alternately repeated triangular form. In the U.S. PAT. 4.655.397 the pressure drop and the motion is performed in the repeated vortex arrangements. In both cases motion is two - dimensional and is clearly limited on the upper and lower sides by parallel flat or coaxial circular surfaces.

The disadvantage of these conventional systems was the low performance, i.e. the small pressure drop that they were achieving per unit length or step of the path. This disadvantage forced manufacturers to use long distance flow restricting paths. The usual flow restricting paths had lengths up to 100 times the basic step of the meander and were using cylindrical mainly emitter bodies for space reasons (U.S. PAT. 4.215.822 and U.S. PAT. 4.655.397). Alternatively they extended along the whole length of the tube (U.S. PAT. 4.880.167).

For this reason we have developed a new form of flow restricting path of high performance and small size.

In the Drawings 1-7 we will first examine our new flow restricting paths in a conventional emitter without self compensation, which is simply welded inside a tube, with a water inlet onto the emitter and a water outlet onto the tube.

In our new meander-like path, Drawings 1, 2, the form consists of parts of a basic prismatic shape 1 which projects on both sides of the emitter unit 6, from its side to the main axis all along its height. The prismatic form is enclosed by concave 1a and convex 1b almost cylindrical side surfaces, vertical to the base 2, such surfaces converging to a perpendicular edge 3 in the area of the main longitudinal axis of the emitter 6.

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From the base of the emitter, cylindrical craters 4 are raised which, however, terminate half way along the height of the emitter. The craters 4 are developed in the regions of the concave 1a surfaces of the basic prismatic forms 1 which form part of the craters. The concave surface with the crater forms a hydrocyclone with an axis perpendicular to the base 2.

An unlimited number of prisms is raised from the base of the emitter, such prisms having a wedge - shaped form 5 and terminating at the same height as the cylindrical craters 4. The wedge - shaped forms 5 extend approximately radially with reference to the edge 3 of the basic prismatic form 1, with edges 5a with sharp edges and an edge width of 0 - 0.15 d, always vertical to the said edge 3 of the basic form. One side of the wedge - shaped forms 5 is a concave, almost cylindrical surface 5aa, with an axis parallel to the base 2 of the emitter 6, open to the side of the water inlet.

All the forms of the base have a height b, Drawing 1a, sharp edges and leave the cross section at the upper part of the emitter free, for the unobstructed flow of the water. In region d1, Drawing 2, i.e. in the upper part of the emitter, no forms other than the basic ones 1 are found. From the development of the cross sections along the total path of the water, it can be seen that the smaller cross section appears only in the regions of the edges of the forms 5 of the base. All other regions have a cross section far larger (almost double), something important for avoiding blockages.

Water inflow is via the filters 9 of the base 2, Drawing 1 and water outflow is effected via the hole 11 opened on the tube 10, above the region 12 of the emitter 6.

The flow of the water 7 in the emitter, Drawing 3 and 4, is divided before the hydrocyclone into streams 7a and 7b; stream 7a follows the known hydrocyclone flow, i.e. a, helicoid stream in the beginning, descending to the base following the inner jacket of the hydrocyclone and then ascending in a

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helicoid stream of a smaller diameter from the centre by the axis of the hydrocyclone.

The intensive drop of the pressure of the water in the hydrocyclone is due exactly to the reverse motion of the helicoid ascending and descending streams of a different diameter of the stream 7a, something that is not observed in patents already known, e.g. U.S. PAT. 4.215.822 and U.S.PAT. 4.655.397.

After the hydrocyclone, the water changes its direction in order to enter into the next hydrocyclone, and so on.

At this phase of change of direction of the water, the large number of the radially arranged wedge - shaped forms 5 of the base interferes, the concave surface 5aa of which forces the water to form a vortex 8 with an axis of rotation horizontal and parallel to the edge 5a of each radial form 5 which causes the vortex. The axis of rotation of the vortex 8 is at right angles to the rotation angle of the hydrocyclone, with a direction reverse to the principal direction of flow 7, 7b of the upper part of the emitter, Drawing 2.

This large number of horizontal vortices at the lower part of the flow, 7 and 7b creates intensive and successive contractions of the flow above all the edges of the radial forms, i.e. in the whole region of the change of the direction of the water.

At the same time the part 7a of the flow, coming off the hydrocyclone creates a very intensive vortex in the area of the edge 3 with an axis of the vortex perpendicular to the base 2. In each of these perpendicular radial surfaces - cross sections which are defined by the edge 3 and the edges 5a of the prismatic forms 5, these two kinds of vortices act upon. The simultaneous influence of the two perpendicular vortices on the same cross - section, brings about a far larger flow contraction and consequently a larger total pressure drop in the emitter, compared with a situation where each vortex would act alone upon a different cross section of the flow.

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Tests have shown that for the efficient operation of the hydrocyclones as well as for the formation of horizontal vortices, a high value of the depth b is required. Values of b must be in the regions:

$0.8\ d \geq b \geq 0.5\ d$,

where d: is the basic step and the distance between the edges 3 of the basic forms 1.

Regarding d, d1, d2, the following must hold:

$d1 < d < 1.3\ d1$; $d2 \geq d$,

where d1 is the height and d2 the width of the path in the region of the edge 3.

The pressure drop, according to our tests, depends apart from the depth b, on the number N of the radial forms 5. For maximum performance, in the region of change of direction of the water, and in particular 70 degrees before and after the basic edge 3, the relationships $1 < N \leq 6$ and $1 < N$ for each elementary surface d x d2 must hold.

It is logical that these special forms of the base increase the number and the intensity of the specific hydraulic resistances for each repeated part of the emitter path or per unit length, at the same time increasing the total pressure drop in the emitter. Hence, the increase of these specific resistances increases the performance and affects the total pressure drop, far more that the increase of the length of the emitter itself.

Additional advantages of the new emitters are:

- Turbulent flow is achieved even in low pressure regions and small water flow rates.
- The pressure drop is at least doubled for a certain length and water flow cross sectional area, giving the new emitters higher efficiency in comparison with common emitters as those of the U.S. PAT 4.215.822 and 4.655.397.

This advantage permits the manufacture of emitters of a very small size, for a given cross section of the path for the water flow to the emitter, something necessary for the

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manufacture of modern dripline ducts with thin walls, where emitters of a big size and length tend to be easily detached or to pierce and destroy the thin walls of the tubes.

The new emitter is not prone to blockages. The typical water flow cross sections d_1xd and d_1xd_2, whereas they represent the narrowest parts, are always enclosed within two sharp edges 3 and 5, Drawing 1, at an angle of 90 degrees to each other. No foreign particle can thus stop, remain or get wedged onto these edge. Due to the contraction of the flow, velocities in this part are far higher than in other parts of the path. A particle that might enter this region, would either fall in front or behind the said cross section, in spaces of double or triple its volume, i.e. within the cellular cavities of the base with the large depth b.

In these cellular spaces, vorticity has an intensity, direction and speed that will keep the particle rotating, without obstructing the flow of the water, until its dimensions are reduced because of mechanical friction and its removal become possible.

As the cross section along the path is continuously varying but remains always larger (due to the additional depth b of the base) compared to any of the existing emitters, the hydraulic resistance of the total path under low water pressure conditions in the network (e.g. at the ends of the irrigation lines or during start-up) is always lower therefore the drop of pressure is lower than in existing emitters with narrower paths. On the other hand, when high pressures prevail in the network, the hydraulic resistance is far higher than in existing systems, due to the large number and the extent of the specific hydraulic resistance. As a result, the flow is comparatively higher in low network pressures and lower in high network pressures. The characteristic curve of the Discharge vs. Pressure of the emitter, is more flat and water supply more uniform. Thus, smaller deviations of water flow to the emitter are caused by large deviations of the pressure in the network. Such result is

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not achievable with the known emitters, to whichever extent the length of their path is increased. This enables larger lengths of dripline ducts, without intermediate supply by central ducts, with a significant cost reduction.

In another realisation, the surface of the crater 4 of the hydrocyclone, can be open along one part, across the whole height b, 4a, Drawing 3. Similarly, a smaller hydrocyclone with crater 4c may be added opposite to the basic hydrocyclone 4, Drawing 5.

Drawings 6a, 6b illustrate an emitter with small craters and a symmetric basic prismatic form 57, consisting of flat, 57b and concave, 57a surfaces. Each of the radially extending forms of the base, with straight edges 5a have a different shaping. The form 5f consists of symmetrical flat surfaces with an isosceles triangle cross section, the form 5e consists of flat surfaces with a right - angled triangle cross section, whereas form 5 is similar to that of Drawing 1.

Drawing 6c illustrates an emitter with non - symmetrical, basic prismatic forms extending to both sides, hydrocyclones of different dimensions and radially extending forms.

Drawing 6 illustrates an emitter with a basic prismatic form in the shape of a right - angled triangle, a small hydrocyclone and smaller basic prismatic forms 1c at the ends of the prismatic forms of the base, which can be arranged radiallly, 5b, or in another direction, 5g, or parts of prismatic forms 5d, 5e or simple raised pins 5h. The forms of the base can have curved edges, 5c.

Drawing 6d illustrates an emitter with an inclination of the symmetric basic form, smaller than 90 degrees and radially arranged forms. In general, any combination of three kind of forms, i.e. the basic prismatic form, the hydrocyclone, the radially extending forms, or of two of the above, can be manufactured. In a simplistic form, one could resemble the flow as a movement of the water on top of cavities, open or closed, with sharp edges and a cavity surface of the cavity smaller than

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the elementary surface d x d2 and a signifiicant depth b, where $0.8d \geq b \geq 0.5d$.

In another realisation of the invention (Drawing 7), the new flow restricting path could be formed as a closed cylindrical surface, with the form being developed along the external surface of the cylindrical disk 13. The meander form will be supplied by a new circular base, 14 which will bear the nozzle for water inlet to the emitter. A second external coaxial cylinder with a flat circular base, 15, which will bear the nozzle for water outlet 11 from the emitter, will cover the external part of the first cylinder which bears the path. The internal cylindrical surface of the external cylinder 15, will form the cover of the water path. These two cylinders will form the emitter.

In another realisation of the invention for ON - LINE emitters, the form of the path could be engraved in the periphery of the flat surfaces of a disk similar to disk 13 of Drawing 7 (not drawn). Such forms could be engraved either to the upper or the lower surface of this disk, with the water passing at first to the lower and then to the upper path of the disk.

In another realisation of the invention for IN - LINE positioned cylindrical emitters, this form could be engraved on the outer surface of the cylindrical emitter. In this case, the internal surface of the tube would form the external surface of the water path (not drawn).

Another aspect that has not received adequate research yet is the filtering of water at the inlet of the paths, and in general at the inlet of the emitter.

Systems that have been developed so far involved cylindrical holes (EPO, A1 01, 38636) whether of a polygon or rectangular shape. Such holes had constant dimensions, with one dimension normally smaller than the narrowest dimension of the water paths in the emitter, e.g. f<d, Drawing 1. Also, the emitters described in U.S. PAT 4,147,307, U.S. PAT. 4.344.576,

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EPO A1 0006,755, U.S. PAT. 4.382.549 that could be considered to have some filtering capabilities, what they really possess is flashing out capabilities, as during the water supply compensation they just increase or decrease the dimensions of the narrow cross section of the water flow, only after the water with the foreign particles has entered into the emitter.

In our new self compensating emitter the water is filtered upon inlet by an elastic membrane which cover and encircles the sharp edges of a closed cavity. On the cavity edges, shallow radial channels or wedge shaped protrusions which form wide and shallow channels between them are engraved. In the centre of the cavity a hole exists, wherefrom the water passes to a flow restricting path before it is discharged to the atmosphere.

The water enters from the shallow channels of the sharp edges under the membrane which moves and bends continuously over the cavity due to the pressure difference between its upper and lower surface.

The geometry, as well as the synergy between the cavity and the moving membrane, causes them to move continuously relative to each other, in a manner that the membrane will always push the foreign particles which accumulate in the periphery of the cavity or on the membrane itself, removing them from the emitter.

In Drawings 8 - 11, a self compensating emitter of our invention is described, such emitter being suitable for attachment to the inner part of a tube.

The body of the emitter 16 bears a closed, almost spherical cavity (17) with sharp edges (17a) and shallow channels engraved radially (18) along the whole internal surface of the cavity, whereas a membrane (24) just covers the edges (17a) of the cavity. At the centre of the cavity 17, a hole 19 with a rim 19a is located. The water enters from the shallow channels 18 into the cavity wherefrom it passes via the hole 19 towards the meander path 20, and from there via the chamber 21

and the hole 22 of the tube 23, it is discharged to the atmosphere.

The internal surface 17b of the cavity and the cylindrical side surface 24a of the membrane 24 constitute the filter of the emitter.

Drawings 8a - 8c describe the self compensating operation of the flow and the self - cleaning features of this filter.

The water inlet via the shallow channels 18 under the membrane creates reduce pressure conditions depending on the extent of which the membrane 24 is bent and assumes every time a fully defined position with a distance x1 relative to the rim 19a, so that the flow through the emitter remains constant. In higher pressures, the membrane enters into the small cavities of the channels 18, reducing even further the water supply.

If in the particular operating position, a compact ring of foreign particles 25 concentrates around the whole surface 24a or part thereof, the filter will close completely and the flow of water towards the open flow restricting path 20 will be interrupted. Due to the above event, the pressure in the cavity 17 will be reduced further with the result that the membrane 24 moves nearer to the rim 19a of the hole 19, position x2, Drawing 8b, where x2<x1. At the same time, the side surface 24a of the membrane 24 is displaced from the ring 25, the flow in the flow restricting path is resumed by the new void created and the membrane returns to the position x1, and so on. This continue interchange between positions x1 and x2, destroys or disturbs the cohesion of the compact ring of foreign particles 25, such ring eventually being removed completely from the emitter, each time that the irrigation phase is interrupted, completed or repeated, as the membrane returns then to its original horizontal position, Drawing 8c and scrapes automatically the foreign particles.

In general, we observe that a relative motion exists between the side surface 24a of the membrane and the internal surface 17b of the cavity, this motion contributing to the

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mechanical removal of foreign particles and the self - cleaning of the filter. For each value of the internal pressure PE of the water in the tube 23, the membrane 24, and in particular its surface 24a reaches a different peripheral contour line passing from the points A, B, etc.

In the variation of Drawing 8d, the membrane 24 has a bigger dimension Δ, and covers the cavity. In this case, the relative motion scrapes the ring of foreign particles 25 immediately from the membrane itself and the emitter.

Experimental application has shown that best results are achieved when the following relationships hold:

$d \leq a \qquad 3\,D1 < D2 < 10\,D1$

where d is the thickness of the membrane 24, a is the distance of it from the rim 19a, D the diameter of the hole 19, D2 the diameter of the membrane.

In Drawings 10a - 10b - 10c another variation is described, where the cavity 17 could have an oval form for increasing the length of its perimeter and the surface of the filter. In the same variation the hole 19 is eccentric and peripheral, closed protruding contours appear in the internal surface of the cavity, which actually constitute successive contact positions of the membrane with the cavity, during the sequential descent of the membrane during the phase of self compensation of the water flow to the emitter.

The motion of the water, in the beginning, in the shallow channels creates a pressure reduction and the membrane starts to descend towards the contours 26a, 26b. As the contour 26a, is already distant from the base by a length Xa, the velocity of water is higher in the void between the edge of the contour and the membrane, resulting in pulling the membrane and lowering it into the periphery of the cavity 17. The membrane is also lowered between the spaces between two successive protruding contours as well. The phenomenon is understood by comparing the positions 24b and 24c. Position 24c corresponds to a variation of a flat base 27.

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This additional lowering is due to the fact that the pressure in this case is not the same at all points under the membrane, as it happens in a flat base variation 27, but is gradually reduced from one contour to another. The same pressure applies only along all the whole peripheral void, between two successive contours.

The advantage of the contours is the increase of the relative motion between the edges 17b and the surface 24a for better scraping of foreign particles.

Another advantage (apart from proper filtering) is the ability to maintain steady water flow in the emitter for all water pressures in the tube, in a far more efficient manner, as the compensation of the void spaces in the water inlet is gradual, in a larger number of far bigger surfaces and points and with a smaller pressure difference from one surface to another. In existing flow compensating systems with a flat and smooth base 27, U.S. PAT. 4.307.841, the compensation of the flow is exclusively performed on the rim 19a of the outlet hole and with a far higher pressure difference before and after the rim 19a.

Finally, the positioning of the filtering system before the flow restricting path 20 of Drawing 8, has the advantage that due to the permanent throttling of the water in the shallow channels 18, even in the beginning of the operation of the emitter, i.e. in the flushing out phase, the usual sudden increase of water discharge (which can lead to a doubling of the latter) is avoided, prior to the activation of the membrane. The phenomenon of this sudden increase of the discharge in the start - up of the operation, causes the known significant problems originated by a prolonged non-uniformity of the outlet of the emitters, as the supply of the networks and the pumps is not sufficient for such a momentary increase.

For this reason the meander 20 can be omitted without causing a problem of a sudden increase of the discharge; the hole 19 then discharges directly to the atmosphere. Should the

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meander remain in place, there is a possibility to increase its cross section area considerably in order to avoid all blockage problems, as the pressure drop in the filter has already decreased the velocity of the water. As the biggest problem associates with blockages is caused just by this conventional flow restricting path 20, emitters of exceptionally small discharge could be manufactured, with a spacious flow restricting path, or even without one.

Drawings 8e and 8f illustrate two variations of the membrane 24. In one of these variations, the membrane bears radial cuts; in the other it is thinner in its periphery. Both variations facilitate a more intense bending in the periphery of the membrane, with an increase of the relative movement of the membrane and the emitter.

In another variation the filter system terminates to a straight line instead of a periphery of a circle.

In another variation, Drawings 10d - 10f, the filtering space f is considerably more spacious. In the place of the external perimetric edges 17a, Drawing 8, the arms 28 are fitted which support the membrane 24, whereas the cavity 17 essentially is substituted by the perimetric contour protrusion 26a at a considerable distance f from the membrane 24. Reduced pressure is created by the motion of the water through the void space f, the extent of this pressure reduction regulating the operating positions of the membrane, 24e, 24f etc. which is supported and slides on the internal surface 28a of the arms 28. As in the first variation of Drawings 8 - 9, filtering occurs along with water supply compensation, as the distance x1, Drawing 10f, between the membrane and the rim of the hole 19, is reduced as the pressure in the tube increases.

The position and the size of the ring 25 of the foreign particles is also compensated by the operating position. As the relationship f << D1, always holds, during the return of the membrane to the original position 24d, the foreign particles

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pass easily, even through the outlet hole D1. For better performance, the relationship: 3<D2/D1<10 must always hold.

In another variation, the contours (26a, etc.) can be altogether omitted and the cavity 17 can be flat.

Drawing 10g illustrates a variation, where the membrane 24 is not flat but essentially has the form of the cavity 17 of Drawing 8, with the rim 19a, the contours 26a, 26b and the arms 28, radially arranged so that the periphery of the void space f is defined. Furthermore, the arms 28, as well as the contours can be omitted and a large number of small shallow radially extending channels be found in their place. Such channels can be saw-shaped or have a different cross section. They extend along the whole length of the edge along which the membrane comes into contact with the emitter.

Drawings 10h, 10i, 10k, 10l, illustrate another variation of a filter. The minimum width slots 41, divide the elastomeric shell 24 into bands of an alternating small (42) and large (42a) thickness. With the water pressure, the bands 42 are pushed further than the bands 42a, thus creating a relative motion of the bands 42 and 42a, perpendicular to the base, along the whole length of the slots 41, which does not influence the width of the slots. In any interruption of the irrigation process, the bands 42 return, scraping the foreign material from the slots 41. In the Drawing 10i the slots 41 are parts of circles. In another variation the bands may have the same thickness but be free (as a projecting beam) at one end for higher flexibility. Similar bands can also exist in flat membranes.

Also, in another variation it is possible that after the compensation of the discharge performed by the filter, another cavity with a hole is present as well, after the flow restricting meander - like path 20, where the final compensation of the water supply is performed by the membrane itself (not drawn).

It is also obvious that a dynamic filter with a moving membrane can operate only as an inlet filter of the water

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without a significant pressure drop, and that another system for the final compensation of the water supply using the same membrane, is fitted after the flow restricting meander - like path to assure the stability of the water supply. It is also possible that the flow restricting path is absent and that both the filtering and the compensation of the supply are only performed in the cavity 17 (not drawn). It is also possible that the membrane operates in only two positions.

Drawings 10m, 10n illustrate a variation where the flow restricting meander - like path 20 exist at the base of the cavity 17. In this case, the small channels at the edges of the contour protrusion 26b are more concentrated in the beginning of the path 20. The filtering is performed in the whole periphery of the emitter, whereas the constant supply is assured both in the contours or the inlet of the cavity 21, and/or the rim 19.

Techniques known so far for compensating the water flowrate in the emitter use one single cavity, with one outlet hole and one rim on top of which a membrane moves (e.g. U.S.PAT. 4.307.841).

A determined position - distance of the membrane from the rim of the inlet hole corresponds to every value of the pressure of the water in the tube.

An essential disadvantage of the techniques already known is that for pressures larger than a particular pressure in the tube, the membrane touches completely the rim of the outlet hole. For even larger pressures the motion of the water is continued only via some small channel existing on the rim of the hole. The cross section of the flow in these pressure regions is far smaller than the hole of any conventional filter and the flow in the small channel is continuously interrupted, resulting in very non-uniform discharge.

Given as well the value of the maximum balance depth of the membrane, the accuracy and the sensitivity of the compensation depends on the size of the maximum pressure in the tube, for which the operation of the emitter has been programmed

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and is recommended. According to the above, the sensitivity of known systems is very small, as they only use one cavity with one hole, whereas a high operating pressure corresponds to a given width of the maximum balance depth of the membrane. For this reason the operation of these emitter for high mains pressure or heavily inclined grounds is not recommended.

In the Drawings 12 - 21 we will examine a new variation of a self compensating emitter, where after the water inlet filter, a new procedure for the compensation of the water supply is performed. The compensation process is performed in successive stages and in various positions of the path. The compensation is also connected with a successive and very intensive drop of the water pressure and has as a result the increase of the cross sections, the improvement of quality of compensation , the increase of the sensitivity of the compensation and the ability to use the emitters at high pressures or highly inclined grounds.

The membrane 24 in the new emitter has been extended and covers two new cavities 31 and 33 which bear two holes 29, 29a and 30, 30a of the same diameter, symmetric and placed very close to each other with common rims 29b and 30b, respectively.

The water passes successively from the filter 17a, the hole 19, the spaces 61 and 31, the holes 29, 29a, the spaces 32 and 33, the holes 30, 30a, the space 34 and from there it is discharged to the atmosphere via the hole 22 of the tube 23.

In Drawing 16 we will first examine the behaviour of water in one of the cavities with the 2 holes and the membrane and will assume that the membrane 24 balances at a distance x from the common rim 29b of the holes 29, 29a under the influence of the pressures PE in the tube and P3 in the space 61. As the holes have the same diameter, D1, they are located very close to each other and for each value of the pressure in the tube they are at the same distance x from the membrane. The pressure P3 of the space 61 is subject, due to frictions on the common rim 29b, two successive and equal pressure drops, one at the hole 29 at

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the entrance to the cavity 31, $\Delta H3$ = P3-P4 and one at the hole 29a at the outlet from the cavity 31, $\Delta H4=P4-P5=\Delta H3$.

The total pressure drop in a single space, i.e. the cavity 31, $\Delta H3+\Delta H4 = 2\Delta H4 = P3-P5=2\Delta H3$ is exactly double in comparison with the respective pressure drop in a cavity of existing technologies which use a single active hole, the outlet hole, i.e. U.S. PAT. 4.307.841. Another significant difference between the new and the known technologies lies in the fact that as the pressures in the cavities are far smaller than the pressure PE in the tube due to successive throttling in the water, the membrane is bent along the whole surface of the cavity, Drawings 16-16a, even at the periphery, at not only at a point above the hole, as illustrated in the curve 24N, Drawing 16a; as a result, the pressure drop and the efficiency in general are far higher.

As, however, the pressure PE in the tube is constant at a particular time, whereas the pressures in the respective cavities 31, 33, etc. are different at the same time in each of the cavities, the membrane 24 is bent at a different depth on top of the group of two rims of each cavity if the cavities had the same dimensions. This problem can be overcome with the progressive reduction of the dimensions L1, W1 to L2, W2, etc. keeping however, the width or the depth a constant in the cavities. Thus, we achieve the same degree of bending and consequently the same distance x of the membrane simultaneously above all the groups of double rims, 29b, 30b, etc. A similar result is achieved with the progressive increase of the thickness of the membrane.

Drawings 16a, 16b also illustrate a specific arranged and elevated common rim 29c, with an internal diameter W3, aiming to achieve (with the second bending in the internal part of the rim), the same distance x of the membrane 24 in the case where the cavities 31, 33, etc. have the same dimensions L, W.

In another variation the depth of the cavities is gradually increasing, as we advance towards the outlet, so that

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the membrane keeps always during the operation the same distance from all the rims of the cavities (not drawn).

With the unified behaviour of the membrane 24 above all the rims and due to the fact that the throttling of the water is performed at many points - holes simultaneously, a far larger distance from the common rim x is arised in comparison with the existing known systems with one cavity and one hole, in order to achieve a particular pressure drop and consequently a given constant water flow rate. This larger distance x limits the danger of blockages and the number of holes increases the effectiveness of the emitter path.

As, due to the large number of cavities, for a given maximum value a, Drawing 12, of the membrane bending depth, the maximum pressure differences PE - P4 etc., in the different cavities 31, 33, etc. which determine every time the positions of the membranes are far smaller compared with the known systems which use a single hole cavity, the sensitivity, the quality and the reliability of the compensation in the new invention is better.

Another advantage of our new invention is the fact that the distribution of velocities along the perimeter or periphery of the holes 29, 29a is not symmetrical and uniform, as in the known systems, but the velocities are far higher in these parts where one periphery or perimeter approaches the other.

This phenomenon permits us to increase considerably the length of the periphery or of the perimeter, and consequently the cross section of all these holes, without increasing to the same extent the water flow in the emitter.

By arranging a large number of cavities with double holes in the emitter, we can achieve a fully controlled pressure drop, several times higher of that achieved by the known systems. In addition, we can increase several times the maximum recommended working pressure of the emitter which consequently will increase the maximum recomended lateral length of the irrigation tubes, i.e. the tubes upon which the emitters are positioned, with a

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significant reduction of the number of central water supply tubes in the irrigation systems. This leads to a respective reduction of the cost of such systems.

As due to the gradual, uniform and very large increase of the pressure drop along the flow the velocity of the water in the emitter is reduced to the minimum possible, our system permits (for a given water supply) to design cross sections of holes and in general paths in the emitter with a surface area several times larger than that of known systems. This has as a result the minimisation of the risks of blockage which at present constitute the most severe problem and render the use of expensive filters necessary. We also have the capability, should the flow from the hole 22 be interrupted by a blockage to open a second or third hole in the tube above the cavities 61 or 32 reinstating the operation of the emitter. In the Drawing 15a, the cavity 61 bears a path 62, as well.

Our new invention also permits for the first time the production of emitters with extremely low water supply, but with spacious holes and water paths, which will further increase the maximum recommended lateral length of irrigation tubes. Furthermore, the fact that meander - like flow restricting paths are absent, the cost of construction of the emitter is significantly lower.

Drawing 16c illustrates a variation, where the two rims have a different height ΔX. In this case the membrane 24 cannot be bent uniformly above the rims, and the pressure differences occurring are different. If the rim of the inlet hole 29 is higher than the rim of the outlet hole 29a, then : $P3 - P4 > P4 - P5$. On the contrary if the rim of the hole 29a is higher then: $P3 - P4 < P4 - P5$ (not drown). It is also possible that the rim of the hole 29a is so high that the membrane does never touch the rim 29. In this case P3 is equal to P4 and the rim 29 does not influence the compensation, of the water discharge.

In the Drawings 17 - 17b, a variation is illustrated with 4 holes, two for input to the space 31 (29, 29d) and two for

output from the same space, 29a, 29e. Both the inlet and outlet holes have a considerable difference in the height of the rims ΔX. The holes 29 and 29a bear a tiny channel 29f and 29g which is directed towards the holes 29d and 29e respectively.

Water from the space 61 enters into the space 31, at the beginning simultaneously from both holes 29 and 29d. Immediately after the beginning of the operation, the membrane 24 covers both the so vigoroys raised rim 29 and its small channel 29f completely. Both the flow and the compensation of the supply is now performed only via the hole 29d which is called main inlet hole.

A similar phenomenon occurs with the outlet holes 29a, 29e as well, where the hole 29a closes and the flow is maintained only via the hole 29e which is called main water outlet hole. As soon as the main water inlet hole 29d is completely closed following accumulation of foreign particles and flow through it is interrupted, the membrane is raised immediately over its rim 29d and unveils the tiny channel 29f. Both the flow and the compensation of the water supply in this region is performed solely by the auxiliary hole 29 and its tiny channel 29f. Of course, as the flow is for any reason re-established in the main hole 29d, the flow in the auxiliary hole 29 is interrupted by the membrane, so that it is only conducted via the main hole 29d. A similar operation can be performed with the outlet holes, with the hole 29e being the principal one and the hole 29a being the auxiliary one. Obviously, the holes can be more than four, divided in an inlet and an outlet group and with a different rim height for each hole of the same group. Apart from the existence of many auxilliary holes, this renders the procedure of pressure drop more easy, and subsequently of the compensation of the water supply.

Drawing 18 illustrates that the application of the principal and auxiliary hole can be expanded to the known technologies with one cavity and one outlet hole (U.S. PAT 4.307.841), by hole an auxiliary hole 29a into the cavity and

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next to the main hole 29e. Both in this case the rim of the auxiliary hole must be far higher than the rim of the principal hole 29e. As, however, in this case a meander - like flow restricting path 35 exists, and as the blockage is more likely to occur in the path 35, rather than the hole 29e, a space can be created for hole an additional auxiliary hole 29h at some point along the path, with the same geometrical characteristics of height, tiny channel, etc. as in the case of the other auxiliary hole 29a. In the same manner, the phenomenon can be applied to known, simpler technologies, where the flow restricting meander - like path 35 is absent and where only the mainly compensating cavity 31 with the outlet hole 29e exist. In these cases it is obviously enough to open an auxiliary hole 29a (not drawn). The auxiliary holes in general double the life of the emitter which is rendered useless in principle, due to the large problem associated with the blockages. This can also be applied to the cylindrical emitters WO 93/02547 and E.P AO 018088.

Drawings 19 - 19a illustrate a different variation, where the cavities are continuous and holes 19, 29, 29a, 30, 30a in the spaces 17, 31, 33 of the emitter of the Drawings 12, 13, 14, 15 are replaced here by channels which are formed between two prismatic forms with inclined edges. The edges 36, 37 of the channels 29, 29a of the cavity 31 correspond as far as this matter is concerned to the characteristic pair of holes 29, 29a of the emitter of the Drawings 12, 13, 14, 15. The length of the cavities L1, L2 gradually decreased as we advance towards the oytlet 22 of the water.

The membrane 24 is bent alternately during the operation above all the inclined inlet and outlet edges, as it appears by the broken curve 39. The distance of the membrane X from the base is equal for all the cavities. All other matters the filtering as well as the compensation of the discharge are the same with the case of the emitter of the Drawings 12, 13, 14,

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15. The same holds in this case generally as per the case of the cavity with two inlet - outlet holes.

In another variation (not drawn) the membrane 24 is completely omitted but all the rest emitter 16 is built from one and only piece from elastomeric material and is inversely attached on the tube 23, with the cavities 31, 33 towards the internal surface of the tube 23. The compensation of the discharge is performed between the edges of the channels and the internal surface of the tube 23.

Drawings 20 - 20a illustrate another variation with two independent membranes 24c, 24d, where the holes are replaced again by channels 19, 29, 29a, 30, 30a with inclined edges 19a, 36, 37, 38, 38a, but both the filtering of the cavity 17 as well as the compensation of the supply in the cavities 31, 33 are performed simultaneously from two sides of the emitter 16. The body of the emitter 16 is attached internally in the duct by the edges of the cavity 34.

It is obvious that one single elastic tube could be in place of the two independent flat membranes which could cover the emitter. In another variation the whole emitter 16 with the membranes 24c, 24d could be made from one single piece of elastomeric material (not drawn).

In the sequel, we will describe a new variation where the emitter is cylindrical and consists of one single piece of elastomeric material. The known systems of cylindrical emitters made by elastomeric materials, WO 93/02547, EP.A.O. 018.088 and EP.A. 0295.400 have the same disadvantages as the known system of the U.S. PAT. 4.307.81 already described.

In the Drawings 21, 21a, 21b, 21c, 21d, we will describe the new emitter the differences of which relative to the emitter of Drawings 19, 19a consist in that the cavities 17, 31, 33, 34 are cylindrical, as the water inlet filter as well. The emitter is solidly attached to the internal part of the tube 23 with the cylindrical surfaces 39a, 39b, 39c, 39d. The rims 19a, 36, 37, 38, 38a, 38b of the water inlet - outlet holes to the chambers

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are inclined and flat, and the lengths of the cavities L1, L2, L3 are gradually decreased as we advance towards the water outlet 22. The meander - like flow restricting paths in the spaces between the cavities are not necessary, (but they may be exist) as the water pressure is intensively throttled during the passage of the water through the in - series arranged cavities.

The water inlet is performed along the perimeter of the cylindrical surface of the filter. During the inlet of the water from the filter, reduced pressure in the space 17 forces the surface of the cavity 17 to move towards the inner surface of the tube 23, limiting the void between the blades 40 and the internal surface of the tube.

The reduced pressure in the cylindrical spaces 31, 33, 34 causes bending of the walls of the emitter relative to the tube and the pairs of rims 36, 37, etc. approach together to the inner surface of the tube. The pressure drop of the water is gradual from one cavity to another and the bending of the walls is the same, x, in every cavity, due to the progressive reduction of the length L1, L2, L3. In this case, the same holds as for the emitters of Drawings 12, 13, 14, 15 and their variations.

In another variation, the relative positions of the channels 19 - 29 and 29a - 30 are displaced on the periphery so that they are not placed on a straight line.

In another variation the thickness of the wall, ΔW is gradually increased from the cavity 31 until the cavity 34.

In another variation, the filter occupies only one part of the periphery of the emitter.

In the Drawing 21c, a filter is illustrated similar to that of Drawings 10h, 10i, 10k. The two rims 39, 39a of the cavity 17 of the filter are permanently attached onto the tube and the jacket bears narrow longitudinal slots 41 which separate the jacket into alternate thin bands of a small and a large thickness, 42 and 42a respectively.

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In another variation, Drawing 21d, the slots 41 are perpendicular to the axis of the emitter, with the only difference that the bands 42a are supported with protrusions 42b onto the tube, whereas the bands 42 are left free for greater mobility. A relative motion is established between the bands 42 and 42a and along the slots 41. It is obvious that in the inventions of the Drawings 12 - 21, it is not necessary that the distance X of the membrane is the same above all the rims of the cavities.

Drawings 22, 22a illustrate a new variation which further improves the sensitivity of the compensation of the water discharge, also increasing the range of pressures of operation and application of the emitter.

The emitter is positioned onto the tube 23 with the nozzle 43. At the inlet of the emitter, at the end of the hole 19, of a diameter D1, the flat circular surface 19c with a diameter D2 and the acute rim 19c are formed and are fully covered by the membrane 24. The consecutive cavities 17, 31, 33 with the characteristic pairs of holes - channels - rims 19d - 19a, 36-37 and 38-30d in the cavities 17, 31 and 33 respectively are also present. Despite the fact that the rims 38-30d in the space 33 are of a different geometry, one rim belonging to a channel and the other to a hole, the two rims behave as a couple as they are simultaneously covered by the same membrane. The water enters via the hole 19, passes under the rim 19d into the space 17, via the channel 29 into the space 31, via the channel 29a and 30 into the space 33 and via the hole 30a to the atmosphere.

During its passage between the membrane 24 and the rim 19d of the hole 19, creates the known, due to the velocity difference in the peripheries D1 and D2 vacuum, which pulls the membrane 24 onto the surface 19c and the rim 19d. The acute rim 19d increase the velocity difference further. A pressure drop of the water occurs on the surface 19c and the rim 19d, from a level PE inside the tube to a level P1 in the cavities 17 and 45.

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As the pressure P1 is increased and decreased always proportionally to the change of the pressure PE in the tube 23, it is not possible to maintain a constant water flow to the emitter just by the energy of the rim 19d. For this reason it is important that the successive cavities 31, 33, etc., are arranged in the sequel.

The water after the cavity 17 follows almost the same process, as described for the emitter of the Drawing 19, 19a and the compensation of the flow is performed by the characteristic couples of rims of each cavity. The water pressure is thus reduced in a succession, becoming P2 in the cavity 31, and P3 in the cavity 33.

The characteristic difference of this variation of the emitter lies in the fact that the pressure prevailing in the rear part of the membrane in the space 45, is no more the water pressure PE prevailing in the tube 23, but the far lower pressure P1 of the space 17, as this is established immediately after its throttling onto the rim 19d.

In the other part of the membrane 24, in the cavities, pressures P2, P3 prevail, as these pressures are established after the successive pressure drop on the couples of rims,

The bending of the membrane to the position 39 and the distance x from the rims of the channels is proportional to the pressure differences P1-P2 and P1-P3, which in this case are far smaller than the differences PE-P2 and PE-P3, as in the case of the emitter of Drawings 12, 13, 14 or Drawing 19, 19a. For a given maximum width a of the path of the membrane the sensitivity and the accuracy of the compensation of the supply is far larger. In parallel, it must be stressed that the motion of the water under the membrane 24 in the area of the rim 19d and the surface 19c and the attraction that it causes to it, functions as a filter and protects the emitter from the entrance of foreign particles.

Other advantages are: a) the pressure to the body of the emitter is smaller than the pressure in the tube with

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significant economies in the thickness of the walls and the quality of materials; b) the maximum operating pressure of the emitter is increased unlimited along with the maximum effective length of the irrigation lines; c) the membranes are stressed by lower pressures or do not touch the rims at all. Thus, simple synthetic elastomeric materials are used with recycle properties instead of complex silicone compounds; d) absolute control of the forces acting onto the membranes is possible. For improved performance, the following relation must hold: D2/D1 > 2, without this though be binding.

In another variation, Drawing 23, 23a, the pressure in the rear part of the membrane 24 is further reduced by the separation of the space 45 of the Drawing 22, 22a into two distinct and separated cavities 45, 45a, where a pressure P1 prevails in the first cavity and a pressure P2 prevails in the second. Water passes from the space 31, where P2 prevails to a new space 48, and then via the hole 49 to the space 45b behind the membrane carrying along the pressure P2. Thus, in the membrane, above the final cavity 33, even smaller pressures are enacted, P2-P3. The new membrane 24 is illustrated in the Drawing 23a.

Drawing 24 illustrates a new variation where a meander path 31 exists in the cavity 17 before the chamber 33 which is also covered by the membrane. The final compensation of he supply is performed in the chamber 33, onto the couple of the rims 38 and 30d. In another variation, the membrane can avoid coming into contact with the rim 38 of the channel and the compensation can be performed only on the rim 30d, or the acute rim 19d can be absent altogether. In a simpler variation of Drawing 24, the membrane can just cover the rim 19c and to leave both the meander path and the chamber 33 uncovered (not drawn). In other variations, the meander path can exist between or after the flow compensating cavities 31 or 33, at the end of the emitter. Both the membrane and the surface 19c can be non-flat, but spherical, the one being convex and the other concave.

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In the Drawings 25, 25a a variation of an emitter is illustrated. This emitter is suitable for positioning onto a tube with two independent membranes 24d and 24e. The first membrane 24d causes the pressure drop from PE to P1, whereas the second 24e functions on top of an outlet cavity 33 with a couple of holes and rims, 30, 30b - 30a, 30d.

In another variation the cavity 33 can be flat and only bear the hole 30a. It can also feature the channel 30, the hole 30a but the rims 30b be non -active (not drawn)

Drawing 25b illustrates another variation with a membrane from one single part. In other variation a single membrane may exist and be horizontal, one part of it with its lower surface covering the inlet rim and the rest with its upper surface covering the compensating cavities or the flow compensating paths. In other variations, the membranes 24d and 24e may cover more than one cavities or meander - like paths in the emitter (not drawn).

Drawing 25c illustrates a new form of a filter at the inlet of the emitter of Drawing 25. In the centre of the membrane 24e which operates with the same manner as the membrane 24d, a piston 54 is fitted, at the end of which a flexible disk 55 with peripheral slots is fitted as well. The disk is made of the same material with the membrane. The water enters through the slots of the disk 55, initially lifts the membrane 24e by ΔA and then pulls it onto the rim. In this time disk 55 performs a movement by ΔA relative to the surface 57 and removes the foreign particles. The system of Drawing 25d operates in a similar manner with the only difference that in this case we exploit the motion of the membrane 24f into the compensating cavity. The membranes 24e, 24f bear blades 56 for managing a small revolution during the phases of position changing, and the number of the disks 55 can be increased. Furthermore, the piston 54 can bear guides for its appropriate displacement. It is stressed that the disk 55 is efficient even if there is no

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movement relative to the the surface 57 or to the inlet hole of the emitter.

It is stressed that the filter systems of Drawings 8 - 11 can be used to attached emitters as well (not drawn).

Drawings 26, 26a illustrates a variation of the emitter of the Drawings 22, 22a suitable for internal attachment to a tube.

The water enters from a large number of holes 19 under the membrane 24 into the large flat rim 19c, where the first pressure drop of the water of the tube from the value PE to a value P1 in the space 17 and at the beginning of the path 31. The special, non circular, arrangement of the rim 19c and the number of holes 19, is the principal differentiation of the emitter of this variation.

From the flow restricting path 31, the water with a pressure P2 is driven to the cavity 33 with the couple of rims 38-30d and the pressure P3 for the final compensation of the discharge of he emitter. The water discharge to the atmosphere, PA, is performed via the spaces 50 and 51a. In another variation the rim 38 of the cavity 33 can be inactive and the final compensation is performed only on the rim 30d.

Drawings 26b, 26c illustrate another variation where the pressure PE, while reduced to P1 in the space 17, remains unchanged in the space 45 behind the membrane.

Both the variation of the Drawings 26, 26a and of the Drawings 26b, 26c can on the same operation principle be manufactured with the membrane approaching the axis of the tube 23, rather than the inner surface.

Drawings 27, 27a illustrate another variation. The membrane 24 is located near the axis of the tube 23 and is covered by a tight cover 52. The water with a pressure PE, passing through the filter 9 into the space 17, is subject to intensive throttling on the rim of the hole 19, and the pressure P1 is transferred to the space 45 between the cover 52 and the membrane 24. The water supply remains constant with the

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compensation onto the rim of the hole 30 and the meander - like flow restricting path 31.

We have extensively discussed the greater sensitivity of flow compensation and the enhanced protection of the emitter from blockages and the efficiency of the water path achieved when the membrane is equidistant from all cavities and holes.

Our next patent relates to the development of special meander - like flow restricting paths on top of which the membrane balances at the same level along the whole length of the path.

Drawing 28, 28a, 28b illustrate an emitter 16 suitable for attachment to the inner part of the tube, characterised by that the prismatic forms 31a of the path 31 are grooved onto a concave cylindrical surface 16b with an axis parallel to the axis of the emitter, and that the thickness of the membrane 24 is gradually increased towards the outlet of the emitter. The water enters via the filters 9, passes through the path 31 and is directed via the hole 30 outside the tube 23. The vacuum created exerts a force onto the membrane 24 and lowers it towards the cylindrical surface 16b of the prismatic forms 31a of the path 31, with a smaller intensity at the beginning, but then gradually increased to a maximum at the end of the path.

For this reason the thickness of the membrane 24 gradually increases, so that the membrane - broken line 39- has the same distance f from the base 16c of the path 31. Drawing 28b illustrates a cut of the position 39 of the membrane for a particular pressure PE in the tube. We get the same result instead of gradyally increasing the thikness of the membrane when we gradually increase the depth a of the base of the water path (not drown).

Drawings 29 - 29e illustrate another variation where the perpendicular sides 53 of the path 31 are not parallel but converge towards the water outlet, the surfaces of the prismatic forms 31a, 31b, 31c form the surface of an almost conical surface with a generating line almost touching the bottom of the

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path 31, and two other generating lines passing from the points A1, B1, C1. The membrane 24 always has the same thickness. With the gradual decrease of the width of the holes L1, L2, L3, etc., the distance f of the membrane during the operation phase 39, is constant along the length of the emitter.

Drawings 29a, 29b, 29c illustrate the cross sections of the emitter at the points A1, B1, C1 with the respective cuts 39a, 39b, 39c of the membrane 24 for a particular pressure PE in the tube. Drawing 29e illustrates again all the successive cuts 39a, 39b, 39c of the membrane for the same specific pressure PE.

Drawings 30 - 30b illustrate a variation where the membrane has the same thickness and the vertical surfaces 53 of the path which are characterised by the points A1, B1, C1 are parallel, but with a depth which is gradually increased as we are advancing to the outlet 30. The top surfaces of the prismatic forms 31a, 31b, 31c along with the part 16b of the surface 16a of the emitter, consist the surface of an almost conical surface with a generating line being attached to the base 16c of the path 31, the base towards the inlet point and the top of the cone towards the outlet of the emitter, and two generating lines passing from the points A, B, C, outside the path 31.

The differentiation of the width L1, L2, L3 of the holes causes the membrane to be at the same distance f from the base 16c during the operation phase.

Drawing 30b illustrates the cuts a1, a2, a3 of the cone of the path 31 at the points A, A1-B, B1-C, C1 with the respective widths of the holes.

Drawing 30c illustrates the positions of the membrane at the points of the cuts A, A1-B, B1-C, C1 for a particular pressure PE in the tube. It is obvious that the particular meander - like form 31 which has been chosen is totally indicative and does not restrict the invention. In another variation, the generating lines A, B, C, of the cone pass through the meander - like path 31 (not drawn).

In the variations of Drawings 28-30c, before the principal paths of the concave surface 31, a simple meander - like path could be manufactured, with a flat upper surface, though, which is covered by the membrane, so that an initial water pressure drop under the membrane is created, before the principal concave path.

The emitters of the Drawings 28-30 could be manufactured also by elastomeric material and consist of a single part. In this case the membrane is totally absent and the emitters are attached with the surface 16a directly onto the tube (not drawn).

It is also obvious that all the emitters of the present invention (Drawings 1 - 30c), even if they are not referred specifically, can be manufactured, altogether, with elastomeric instead of thermoplastic materials, so that the membranes are reinstated. They are also manufactured in a shape suitable for positioning both onto the tube and into the tube. They can also form part of a cylindrical emitter body suitable for positioning into the tube. Furthermore, wherever membranes are present, these can be located either near the surface of the tube or the axis of the tube, or they may be non-flat.

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Description of the Drawings

Drawing 1 Plan view of a conventional emitter with hydrocyclone and prismatic radial forms.

Drawing 1a Cut X1 - X1 of the emitter of Drawing 1.

Drawing 2 Part of a longitudinal cut X-X of the emitter of Drawing 1

Drawing 3 Schematic representation of principal elements of the emitter of Drawing 1 with one part of the crater open.

Drawing 4 Schematic cut of the principal elements of the hydrocyclone of the emitter of Dr. 1.

Drawing 5 Plan view of a conventional emitter with additional hydrocyclone and prismatic radial forms

Drawing 6 Plan view of a conventional emitter with various forms and arrangements of hydrocyclones and prismatic forms.

Drawing 6a Plan view of a conventional emitter with a smaller hydrocyclone, a symmetric basic prismatic form and three different prismatic forms of its base.

Drawing 6b Cut X-X of the emitter of Drawing 6a.

Drawing 6c Plan view of a conventional emitter with non - symmetric basic prismatic forms and hydrocyclones of different dimensions.

Drawing 6d Plan view of a conventional emitter with an inclination of the symmetric basic prismatic form smaller than 90 degrees.

Drawing 7 Conventional emitter suitable for ON_LINE positioning

Drawing 8 A cut of a self compensating emitter with an inlet filter.

Drawing 8a Detail of the operation of the filter of the emitter of Drawing 8.

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Drawing 8b Detail of the filter of the emitter of Drawing 8 in the phase of full blockage.

Drawing 8c Detail of the filter of the emitter of Drawing 8 in the phase of the return of the membrane to its original position

Drawing 8d Detail of the filter of the emitter of Drawing 8 with a membrane of larger dimensions.

Drawing 8e Variation of the membrane of the filter of the emitter of Drawing 8 with radial slots in the periphery.

Drawing 8f Variation of the membrane of the filter of the emitter of Drawing 8 with a thinner wall in the periphery.

Drawing 9 A view of the emitter of Drawing 8, without a membrane and cover.

Drawing 10.A cut of the emitter of Drawing 8.

Drawing 10a.Part of an emitter with an oval-shaped filter cavity and contours.

Drawing 10b.Cut of the oval-shaped cavity of the emitter of Drawing 10a.

Drawing 10c.Detail of the operation of the oval shaped cavity of the emitter of Drawing 10a, with a comparison of the positions of the membrane.

Drawing 10d.Detail of the variation of the filter with a large void space.

Drawing 10d.View of the variation of Drawing 10d without the membrane.

Drawing 10f.Operating positions of the membrane for different pressures of the variation 10d.

Drawing 10g.Variation of the filter of an emitter with a membrane which is not flat.

Drawing 10h.Variation of the filter of an emitter with a membrane from variable thickness bands.

Drawing 10I.Cut of the filter of Drawing 10h in operation.

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Drawing 10k Plan view of the membrane of the filter of Drawing 10h.

Drawing 101Plan view of the membrane of the filter with circular slots.

Drawing 10m.Emitter with a meander - like flow restricting path at the base of the filter.

Drawing 10n.Cut of the emitter of Drawing 10m.

Drawing 11 Another view of the emitter of Drawing 8.

Drawing 12 A cut of a self compensating emitter with successive two-hole cavities.

Drawing 13 A view of the emitter of Drawing 12 without the membrane.

Drawing 14 Another cut of the emitter of Drawing 12.

Drawing 15 Another view of the emitter of Drawing 12 from the side which is attached to the tube.

Drawing 15a.A view, according to the view of Drawing 15 of a variation of the emitter of Drawing 12 in the shape of a meander.

Drawing 16 Detail and phase of operation of a two-hole cavity of the emitter of Drawing 12.

Drawing 16a Detail and phase of operation of an elevated special rim of the emitter of Drawing 12.

Drawing 16b.View of the rim of Drawing 16a without the membrane.

Drawing 16cDetail and phase of operation of a cavity with unequal rim heights.

Drawing 17 Detail of a four-hole cavity.

Drawing 17aCut X-X and phase of operation of the cavity of Drawing 17.

Drawing 17bCut X-X and phase of operation of the auxiliary hole of Drawing 17.

Drawing 18 Plan view of an emitter of known technology with two auxiliary holes, according to our invention.

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Drawing 19 Cut of an emitter with consecutive cavities and pairs of channels and rims.

Drawing 19a Plan view of the emitter of Drawing 19 without the membrane.

Drawing 20 Cut of an emitter with consecutive cavities and pairs of channels and rims and two independent membranes.

Drawing 20aPlan view of the emitter of Drawing 19 without the membranes.

Drawing 21 Cut of a cylindrical emitter from elastomeric material and consecutive cavities with pairs of channels and rims.

Drawing 21aPlan view of an emitter of the Drawing 21.

Drawing 21bCut of the emitter of Drawing 21 in its phase of operation

Drawing 21cVariation of the filter of the emitter of Drawing 21

Drawing 21dVariation of the filter of the emitter of Drawing 21

Drawing 22 Emitter with consecutive cavities with an arrangement for the reduction of its internal water pressure.

Drawing 22aPlan view of the emitter of Drawing 22, without cover.

Drawing 23 Emitter with consecutive cavities and an additional arrangement for further pressure reduction at the rear part of the membrane.

Drawing 23aPlan view of the membrane of the emitter of Drawing 23.

Drawing 24 Emitter with an arrangement for the reduction of the internal pressure and a meander - like flow restricting path.

Drawing 25 Emitter with an arrangement for the reduction of its internal pressure and two membranes.

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Drawing 25aPlan view of the cavity with the pair of the compensating rims of the emitter of Drawing 25.

Drawing 25bVariation of the membrane of the emitter of Drawing 25.

Drawing 25cCut of the emitter with the nozzle and a filter activated by the inlet membrane.

Drawing 25d Cut of the emitter with the nozzle and a filter activated by the outlet membrane.

Drawing 26 Emitter with an arrangement for the reduction of its internal pressure consisting of a large number of holes.

Drawing 26aCut of the emitter of Drawing 26.

Drawing 26bVariation of the emitter of Drawing 26, where the pressure in the rear part of the membrane is the same with the pressure in the tube.

Drawing 26c Cut of a part of the emitter of Drawing 26b.

Drawing 27 Variation of an emitter with an arrangement for the reduction of the internal pressure with the membrane near the axis of the tube.

Drawing 27aPlan view of the emitter of Drawing 27 from the side of the tube.

Drawing 28 Plan view of an emitter with a meander - like flow restricting path of a concave cylindrical surface and a membrane of a gradually increasing thickness.

Drawing 28aCut of the emitter of Drawing 28.

Drawing 28bCut of the emitter of Drawing 28.

Drawing 29 Emitter with a meander - like path of a concave conical surface with converging vertical sides.

Drawings 29a-d Cuts of the emitter of Drawing 29.

Drawing 29e All the successive cuts of the membrane of the emitter of Drawing 29 are illustrated, for the same water pressure.

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Drawing 30 An emitter of a meander - like flow restricting path of a concave conical surfaces with parallel sides.

Drawing 30aCut of the emitter of Drawing 30.

Drawing 30bAll the cuts of the cone of the path of the emitter of Drawing 30.

Drawing 30cAll the successive cuts of the membrane of the emitter of Drawing 30 are illustrated, for the same water pressure.

CLAIMS

1.A conventional emitter with a path for the reduction of the pressure of the water with a water inlet and outlet; the path consists of repeated part of a basic prismatic form (1) which extend on both sides from the sides to the central longitudinal axis along the whole height of the emitter and which are at a distance d of each other. The path is surrounded by concave (1a) and convex (1b) cylindrical side surfaces, at right angles to the base (2) which converge to an edge (3) vertical to the base, approximately in the area of the central longitudinal axis of the emitter (6) with a water path width d2 in the region of the edge (3), characterised by that cylindrical craters (4) are raised from the base (2), such crates terminating at the height b, approximately at the middle of the height of the emitter; the craters (4) are developed in the areas of the concave (1a) surfaces of the basic prismatic forms (1) which form part of the craters, where such concave surface (1a) forms a hydrocyclone with the crater (4) with an axis perpendicular to the base (2), wherefrom a number N of almost wedge - shaped prisms (5) with sharp edges of an edge width (5a): 0 - 0.15 d, are raised, such prisms terminating at the same height b, with the cylindrical craters (4), where such wedge - shaped forms (5) extend almost radially relative to the edge (3) of the form (1) in the regions which are defined within an angle of 70 degrees before and after the edge (3), with the edges (5a) being straight lines at right angles to the edge (3), and where one surface of such forms (5) is concave and almost cylindrical (5aa) with an axis parallel to the base (2), where such forms (4, 5) have a height b, whereas the basic forms (1) extend along the whole height b+D1 of the emitter, with the values of b almost in the regions 0.5d - 0.8d and 1<N<6, or N>1 for each elementary surface dXd2.

2.Emitter according to claim 1, where the crater (4a), of the hydrocyclone is in some part open, along the height of the crater (4a), or where a smaller crater (4c) with a smaller basic

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form (1c) is also added opposite to the basic one (4) and the basic form (1).

3.Emitter according to claim 1, where the basic triangular form (57) is symmetrical, consists of flat (57b) and concave (57a) surfaces, where of the radial forms of the base have a different formation each, such as symmetrical flat surfaces with an isosceles (57c) or right - angled (5e) triangular cross section, or a concave and a flat surface (5).

4.Emitter according to claim 1, where the basic prismatic forms extending on either side are non - symmetrical (Dr. 6c) and the hydrocyclones have different dimensions.

5.Emitter according to claim 1, where apart from the basic prismatic form which has the shape of a right - angled triangle, smaller prismatic forms exist (1c) at the ends of the prismatic forms of the base, such forms being extending radially (5b) or having a different direction (5g), or parts of forms (5d, 5e) with straight (5b) or curved (5c) edges, or raised pins

6.Emitter according to claim 1, consisting by any combination of the three different types of forms, i.e., the basic prismatic, the hydrocyclone, the radially extending forms of the base, or any combination of only two of the above types of forms.

7.Emitter with a path for the water pressure drop according to claims 1-6, suitable for positioning onto the tube, consisting of two co-axial cylindrical parts (13, 15) and a cylindrical base (14), where the path of the water develops along the periphery of the external jacket of the inner cylindrical disk (13) and is covered externally by the cylinder (15) which bears the water outlet nozzle (11), whereas the water supply from the tube is performed by the nozzle of the cylindrical base (14).

8.Emitter according to claims 1-6, where the path for the water pressure drop is developed at the external surface of a cylindrical body and where the internal surface of the tube forms the external jacket of the water path.

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9.Emitter according to claims1-6, where b<0.5 d or b>0.8 d, and N≥6, with base forms extending to regions further than 70 degrees before and after the basic edge(3).

10.Emitter according to claims 1-6, where the edges of the forms of the bottom are not sharp and the width of the edge 5a is larger than 0.15 d.

11.Self compensating emitter consisting of a cavity (17), an elastic membrane (24) with thickness d and diameter D2, which covers the cavity (17), at the centre of which a hole exists, with a rim (19a) and a diameter D1, where the water inlet to the cavity (17) under the membrane (24) which is at a distance a from the rim of the cavity creates a pressure reduction which forces them membrane (24) to move and be bent continuously, according to the pressure differences, so that the supply is kept constant, such emitter being characterised by that the cavity (17) bears a sharp edge (17a) and radially arranged shallow channels (18) extending to the whole surface (17b) of the cavity (17), by that the membrane (24) covers exactly the edge (17a) of the cavity and that its side surface (24a), due to the relatively movement, displaces foreign particles in a mechanical manner from the edge (17a) and by that the following relations holds:

$$d \leq a, \quad 3\,D1 \leq D2$$

12.Emitter according to claim 11, where the membrane (24, Drawing 8d) has a larger dimension and covers the cavity (17).

13.Emitter according to claims 11-12, where the cavity (17, Drawing 10a) is oval shaped, closed contours (26a, 26b, etc.) appear in its internal surface which are successive contact positions of the membrane with the cavity, and which are positioned at a level below the position (24c) which corresponds to the full immersion of the membrane into a flat- base cavity (27), so that a larger degree of lowering of the membrane in the periphery as well, and a gradual water pressure drop between the contours are achieved.

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14.Emitter according to claims 11-13, where in place of the peripheral edge (17a) arms (28) are located, such arms supporting the membrane (24), where the cavity is replaced by the contour (26a) which is at a semantic distance f from the membrane.

For better performance, the following relations must hold:

$f \ll d1, \quad 3 < D2/D1 < 10$

15.Emitter according to claims 11, 12, 14, where the cavity 17 is flat.

16.Emitter according to claim 13, where a flow restricting meander - like path (20) exists at the base of the cavity.

17.Emitter according to claims 11 - 16, where the membrane bears radially arranged slots or is thinner in the periphery.

18.Emitter according to claims 11 - 17, where $d > a$ and $2D1 < D2$

19.Emitter according to claims 11 - 18, where the membrane is not flat but assumes the different forms of the variations of the cavities (17) of the claims 11-18 or a large number of small shallow radially arranged channels in the shape of a saw or with a different cross - section, relative to the small channels (18) which are developed along the length of the edge, with which the membrane comes into contact with the emitter.

20.Emitter according to claims 11 - 19, where the membranes bear slots(41) and bands (42), (42a) of the same or different thickness of various forms and kinds of supportations, so that a relative movement between the bands is achieved in the region of the slots, without affecting the width of the slots (41).

21.An emitter according to claims 11 -20 where after the cavity (17) and the membrane 24, which covers the mebrane and forms a unified system which can operate as a filter and partially as a flow compensating device, or as a filter only, where, such system is positioned before any other flow compensating arrangement, for achieving the water pressure drop,

a path (20) or where alternatively, other cavities or arrangements may exist for the final flow compensation.

22.Self compensating emitter featuring water inlet - outlet, consisting of cavities (31, 33) with the dimensions L1,W1 and L2,W2 corresponding which feature one inlet hole (29, 30) and one outlet hole (29a, 30a) each, such cavities being covered by a membrane (24) which is located at a distance a from the base of the cavities, the emitter being characterised by that the cavities are arranged in a succession, the holes (29, 29a) (30, 30a) have the same diameter D1, and are positioned symmetrically and very near each other, with almost common rims (29b, 30b) respectively, where the dimensions of the cavities (31, 33) L1 , W1 and L2, W2 are progressively reduced as we advance towards the outlet or the depth a of the cavities is progressively increased as we advance towards the outlet or the thickness of the membrane gradually increases as we advance towards the outlet where the water is subject to exactly the same pressure drop due to friction in each of the two holes of the cavity, as the membrane (24) is in the same depth bent above the common rims (29b, 30b) and maintains a unified distance x from each rim.

23.An emitter according to claim 22, where each cavity has two or more inlet holes (29, 29d, Drawing 17), two or more outlet holes (29a, 29e, Drawing 17) with small channels (29f, 29g) with the height of the rims of the holes of each group being different from hole to hole.

24.A self compensating linear or cylindrical emitter with or without a flow restricting meander - like path and a cavity for pressure compesation of a single main hole or channel, where a second auxiliary hole or a channel of a different rim height exists.

25.An emitter according to claims 22-24 where in the place of the couples of the holes of the cavities (31, 33), couples of channels (29, 29a) appear, being formed between the two prismatic forms with inclined rims (36, 37).

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26.An emitter according to claims 22 - 25 where the cavities (31, 33) are covered from both sides by membranes (24c, 24d).

27.An emitter according to claims 22-25 where the body of such emitter and the cavities (31, 33, 34) are cylindrical, where such cavities have the same thickness ΔW, so that the lengths L1, L2 are gradually decreased as we advance towards the outlet, or where the lengths L1, L2 are the same and the thickness ΔW is increased as we advance towards the outlet, where the water inlet to the emitter is performed along the perimeter via a cylindrical moving filter of a fluctuating void space which is created by the internal surface of the tube and the blades (40) of the emitter, or such filter may occupying only part of the periphery of the emitter.

28.Self compensating emitter with a water inlet hole of a diameter D1, at the end of which a flat surface (19c) has been formed with cavities and holes or channels and rims, for water inlet and outlet into the cavities, with a flat membrane (24) which covers the flat surface (19c) and the cavities, such emitter being characterised by that the flat surface (19c) with the rim (19d) and a diameter D2 (with D2/D1 > 2) is positioned before one or more cavities for the compensation of the water flow, arranged in a succession (17, 31, 32, Drawing 22) or is positioned before meander - like flow restricting paths (31, Dr. 24) where the water flow between the membrane and the flat surface and the rim (19d) causes a drop in the pressure of water, such drop being transferred to the following cavities (17, 31, 33) as well as to the space (45, Drawing 22) behind the membrane.

29.Emitter according to claim 28, where the space behind the membrane (24) is divided into two isolated spaces (45, 45a) and where the pressure prevailing in the second space (45a) is lower than the pressure prevailing in the first space(45).

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30.Emitter according to the claims 22-29, where the water inlet is performed by a large number of holes (19) with a common rim and common flat surface(19c, Drawing 26).

31.Emitter according to claims 28-30 where the flat surface 19c and the flat surface of the membrane are replaced by convex and concave spherical surfaces, or where both surfaces are flat, but the rim (19d) is absent, or where D2/D1 < 2.

32.Emitter according to claims 28-31, where after the throttling surface (19c) at least one meander - like path or one cavity or an arrangement for compesation follows.

33.Emitter according to claims 28-32, where two independent membranes exist (24d, 24e, Drawing 25) the first of which covers at least the rim (19c) or the rim(19c) and meander - like paths and flow compensating cavities or arrangement, and where the other covers flow compensating cavities, or arrangement.

34.Emitter according to claims 22-33, where only one cavity with two holes or two channels, or one hole and one channel with the same or different rim height exists, with or without a meander - like path.

35.Emitter according to claims 22-33, where the distance X of the membrane from the rims or the bottoms of the cavities is each time not exactly the same for all the rims or the bottoms, where the pressure drop is not the same in the two holes - rims of each cavity, where the dimensions of the cavities L, W are not gradually reduced as we advance towards the outlet, and where the depth a of the cavities is not increased progressively as we advance towards the outlet, and the holes have different dimensions.

36.A filter system at the water inlet to the emitter with a nozzle and a hole at the end of which a surface has been formed (19c, Drawing 25c), with a membrane (24e) which covers the surface (19c, Drawing 25c)or the flow compensating cavity (33, Drawing 25d), characterised by that under the membrane (24e) a piston exists (54) with a flexible disk (55) at its end

so that when the membrane is lifted and returns to position on top of the surface (19c, Dr. 25c), or when it is bent over the cavity (33), a relative motion exists between the disk (55) and the nozzle which removes foreign particles.

37.A self compensating emitter with water inlet and outlet with a meander - like path (31), prismatic forms (31a, Drawing 28) and a membrane (24) characterised by that the prismatic forms (31a, Drawing 28) are engraved on to a concave cylindrical surface (16b) with an axis parallel to the axis of the emitter, and by that the thickness of the membrane (24, Drawing 28) is increased progressively as we advance towards the outlet of the emitter, or the depth a of the base is progressively increased as we advance towards the outlet so that with the reduction in the pressure created under the membrane, the distances of the membrane f from the bottom are the same along its whole length.

38.A self compensating emitter with a water inlet and outlet, with a meander - like path (31), prismatic forms (31a, 31b, 31c, Drawing 29), vertical sides(53) and a membrane (24, Drawing 29) of a constant thickness, characterised by that the prismatic forms (31a, 31b, 31c), are engraved onto a conical surface with a generating line almost touching the bottom of the path, two other generating lines passing from the points A1, B1, C1, where the vertical sides (53) of the path (31) converge towards the outlet of the emitter, so that the distances of the membrane from the bottom during the operation are the same along its whole length.

39.A self compensating emitter according to claim 38, where the vertical surfaces(53, Drawing 30) of the path (31) are parallel, their depth progresses gradually as we advance towards the outlet (30) and the two generating lines which are defined by the points A, B, C pass either outside or inside the path (31, Drawing 30).

40. Emitters according to claims 1-39, where or the emitters bodies are manufactured with elastomeric materials, or the membranes are not flat and or the shape of the emitters and

the systems are suitably altered so that their positioning ON-line or IN-Line is possible.

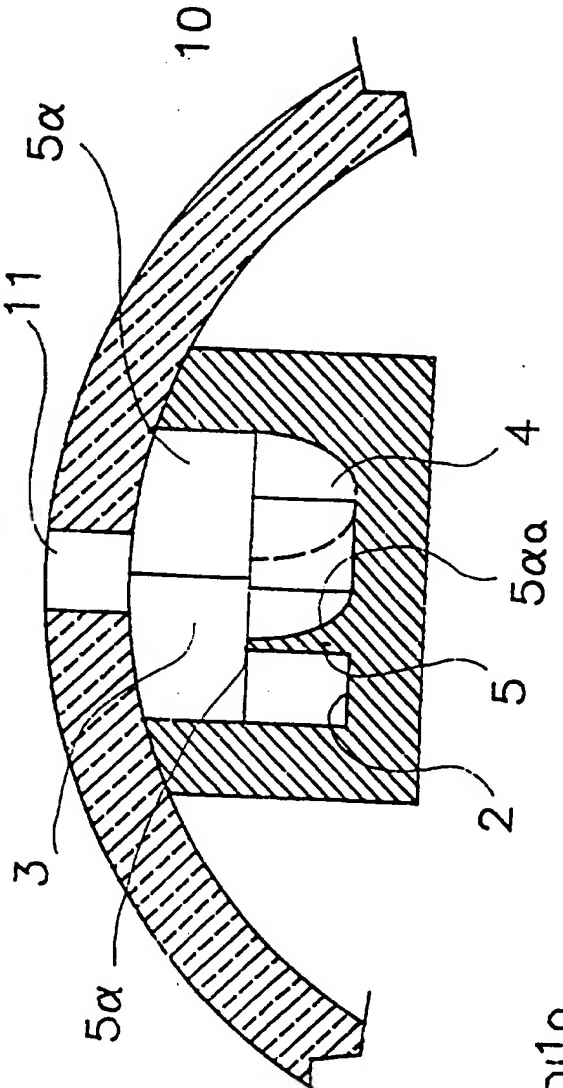

Fig1a

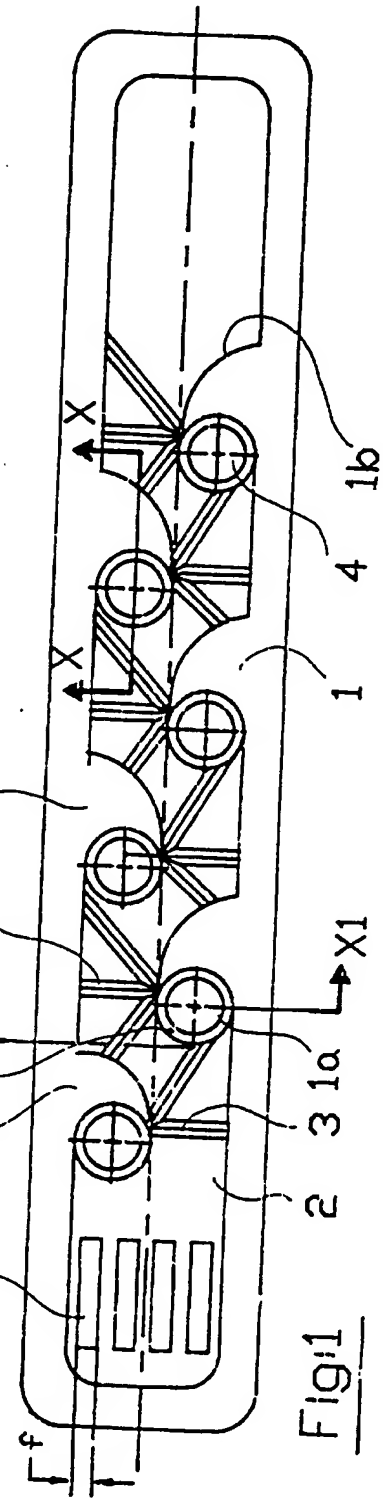

Fig1

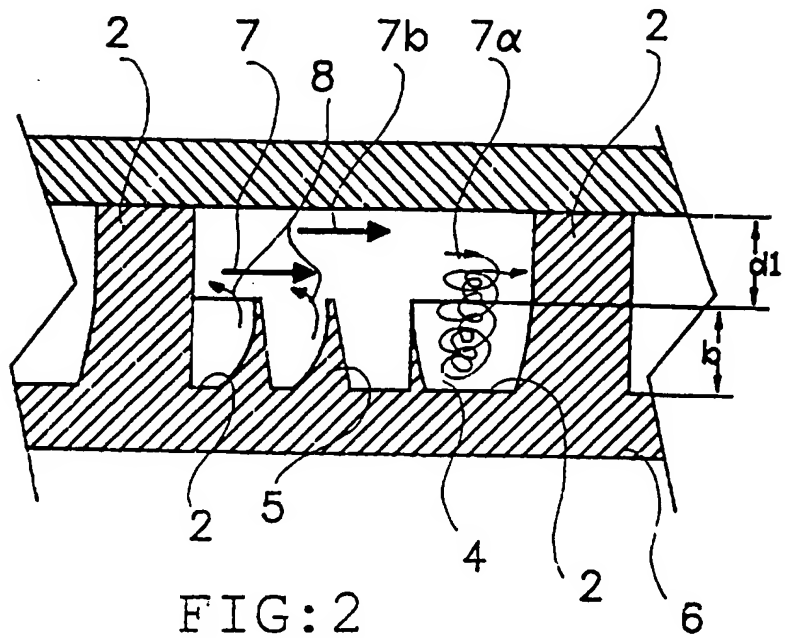

FIG:2

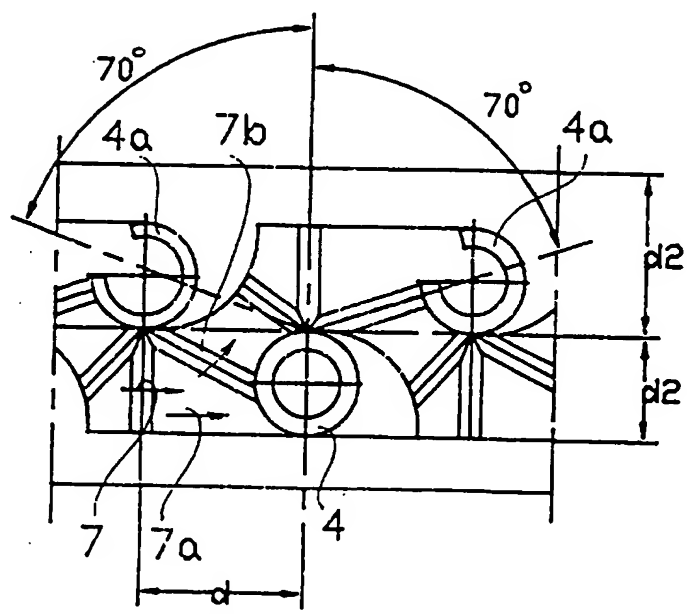

FIG:3

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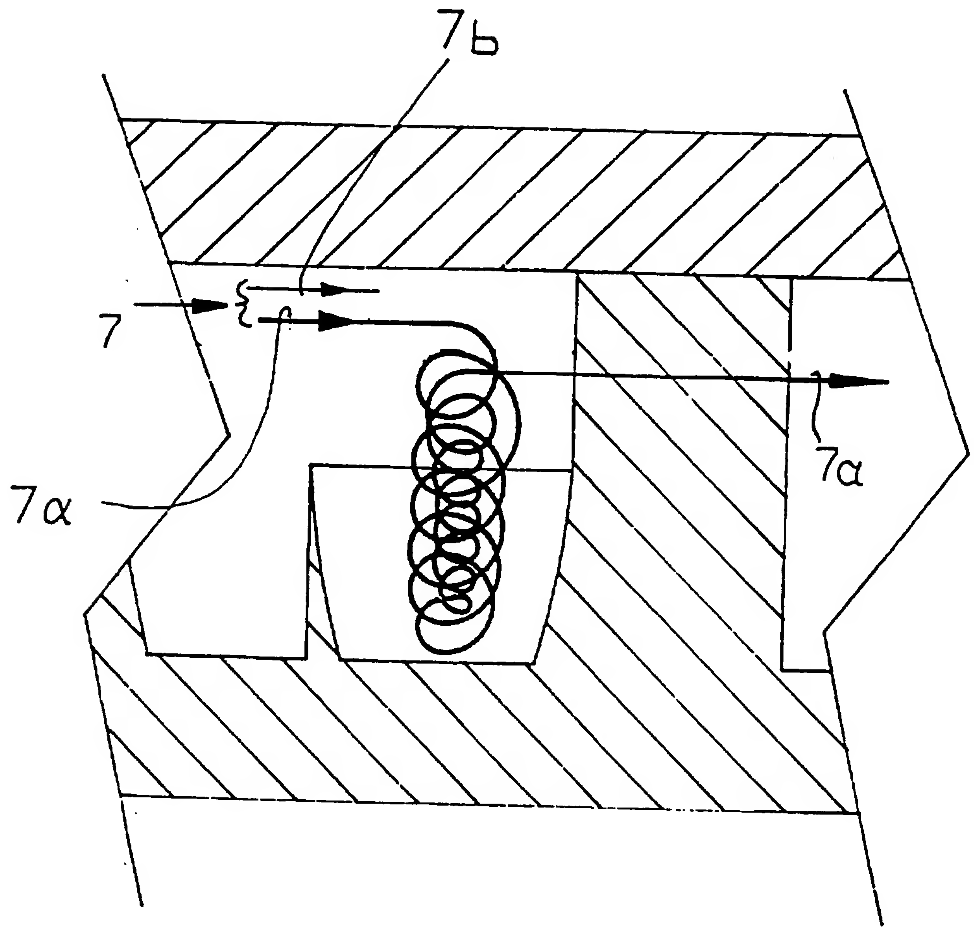

Fig:4

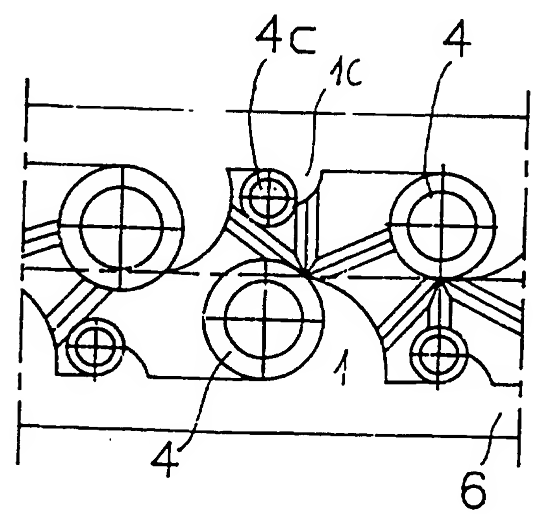

Fig:5

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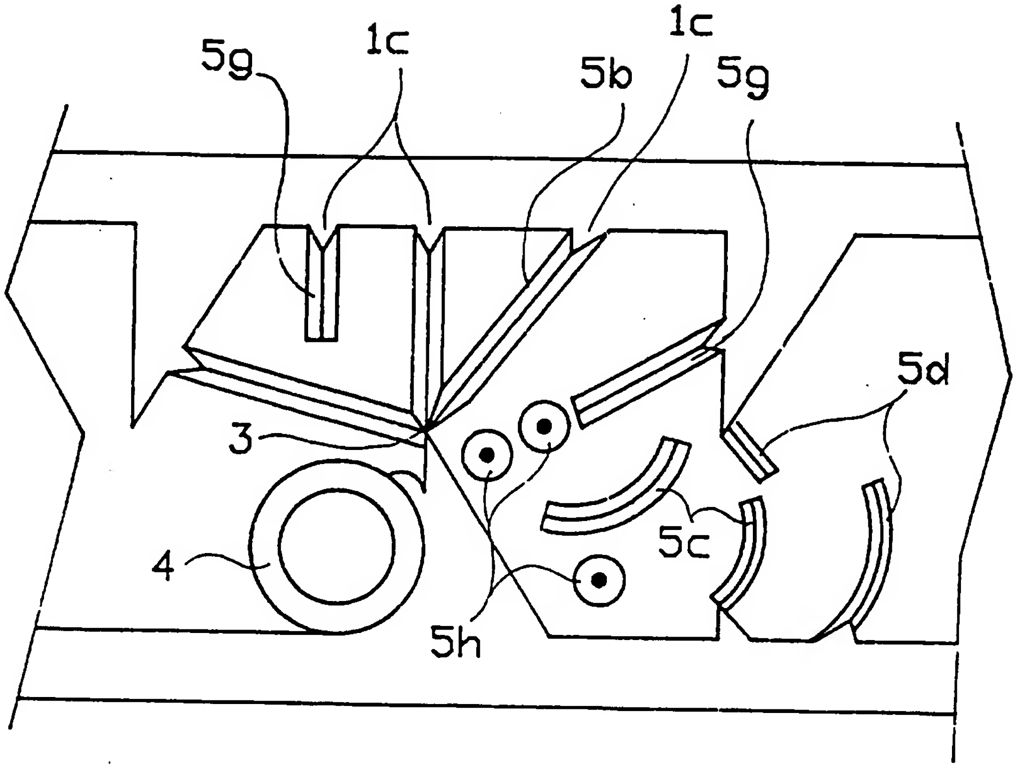

Fig:6

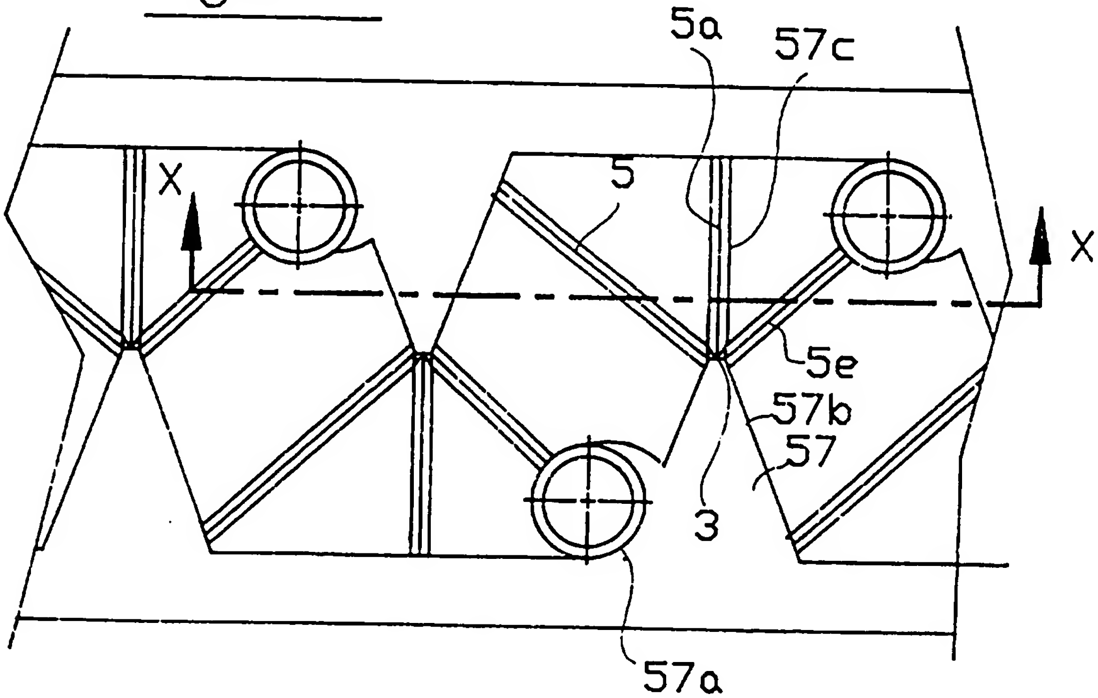

Fig:6a

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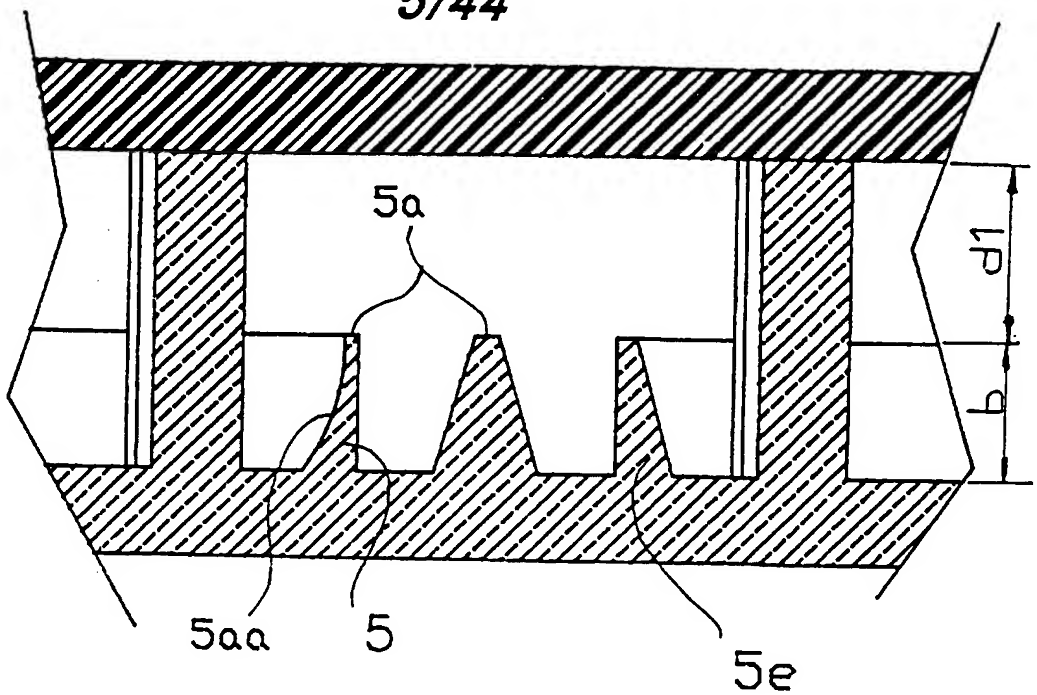

Fig 6b

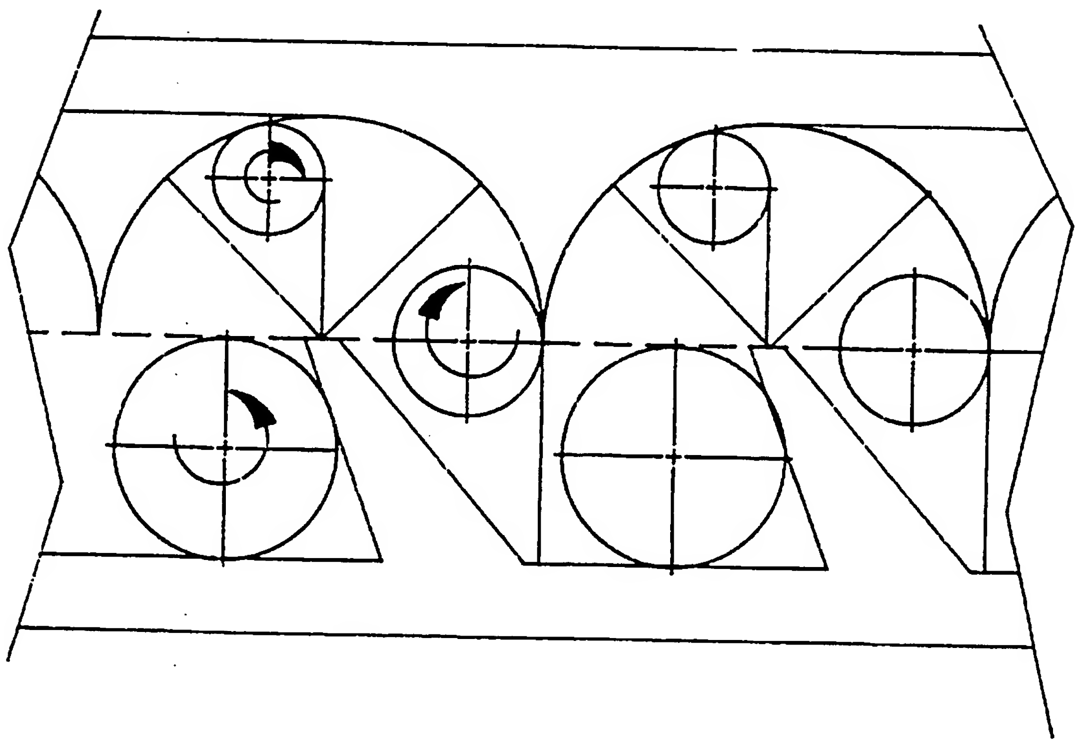

Fig 6c

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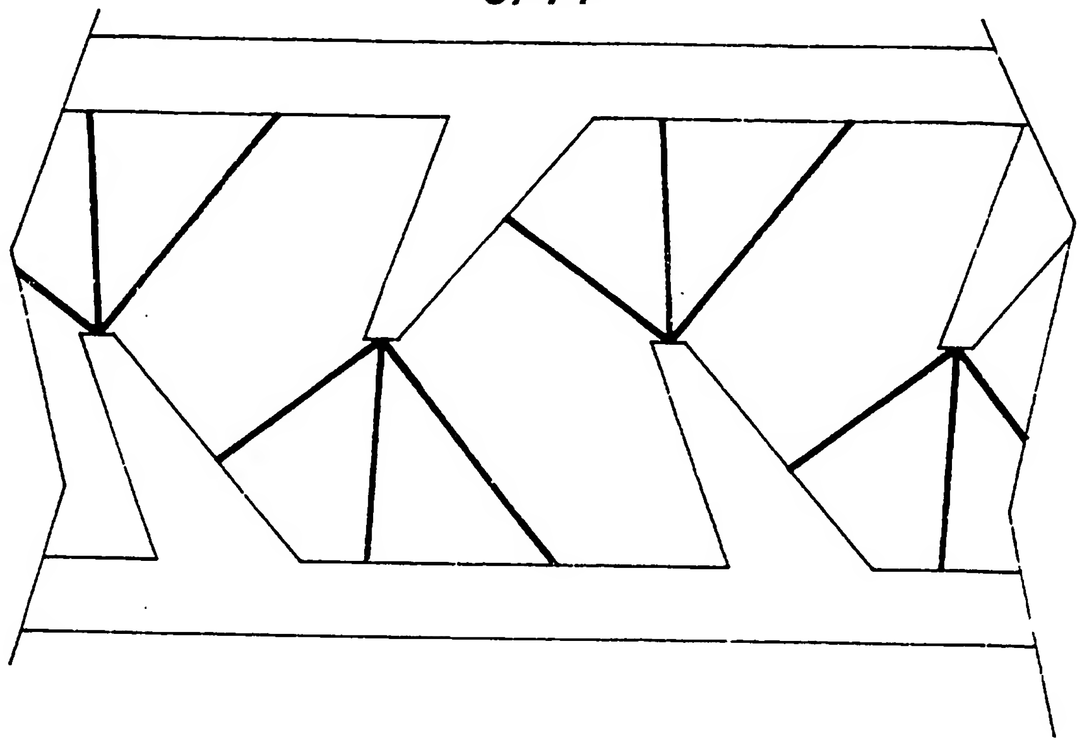

Fig:6d

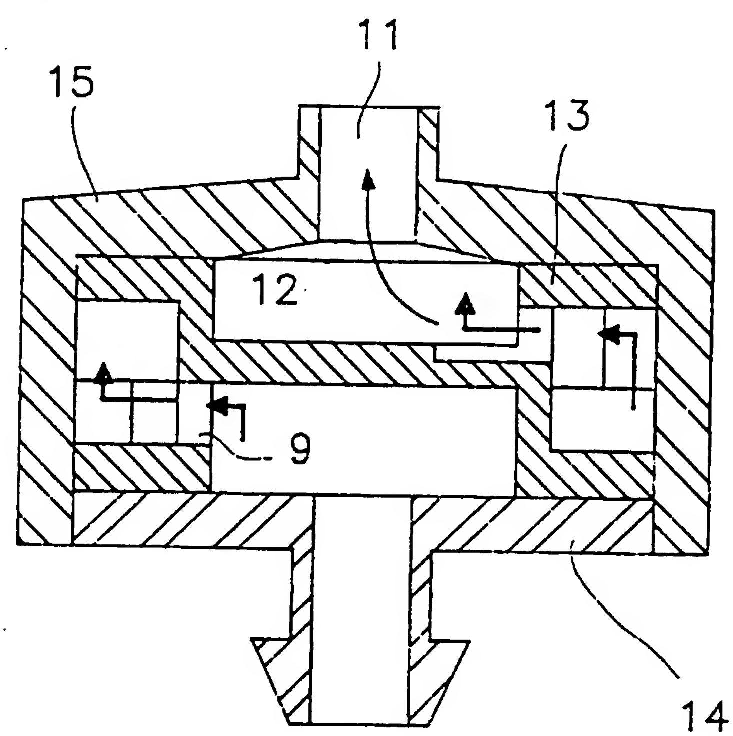

Fig:7

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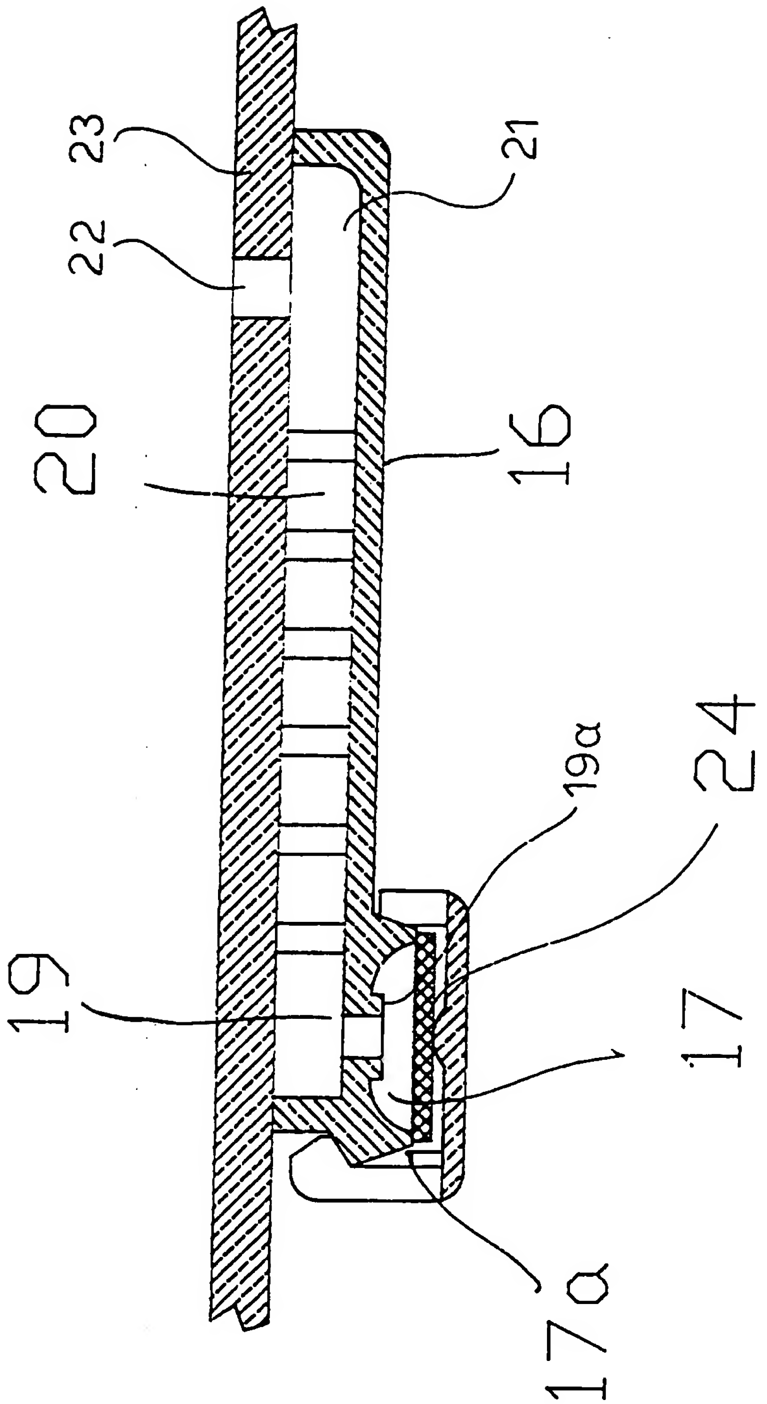

Fig 8

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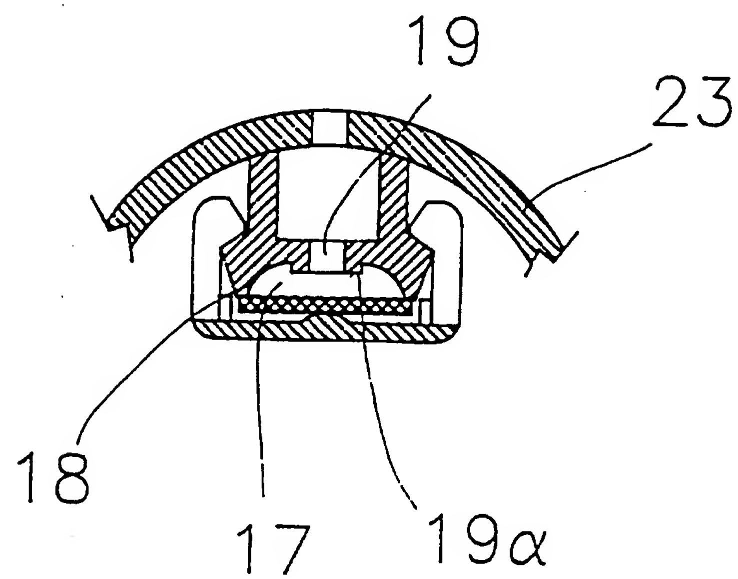

Fig:10

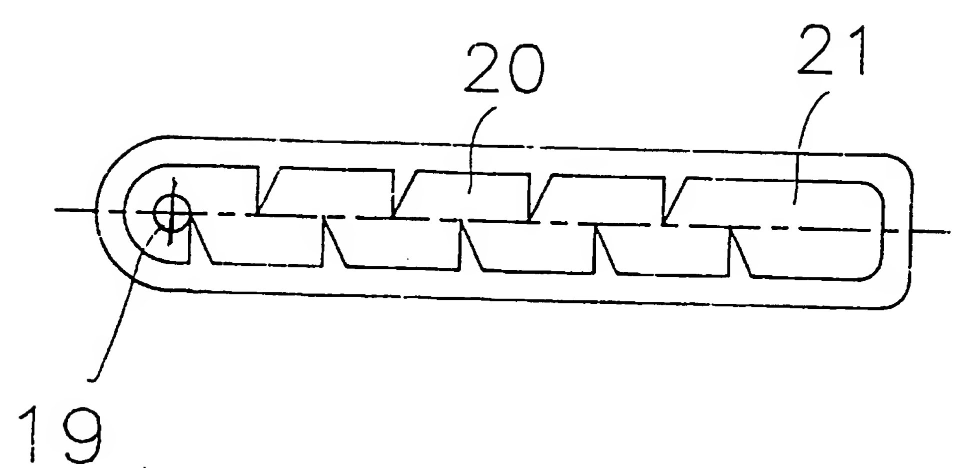

Fig:11

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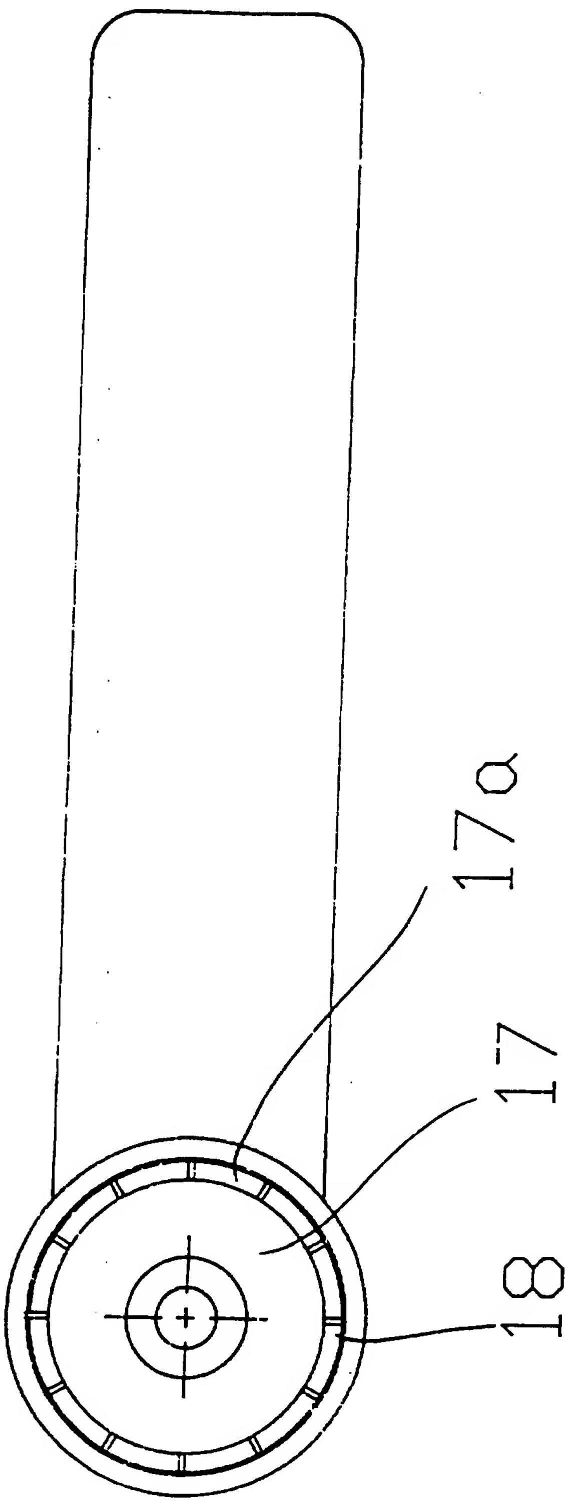

Fig 9

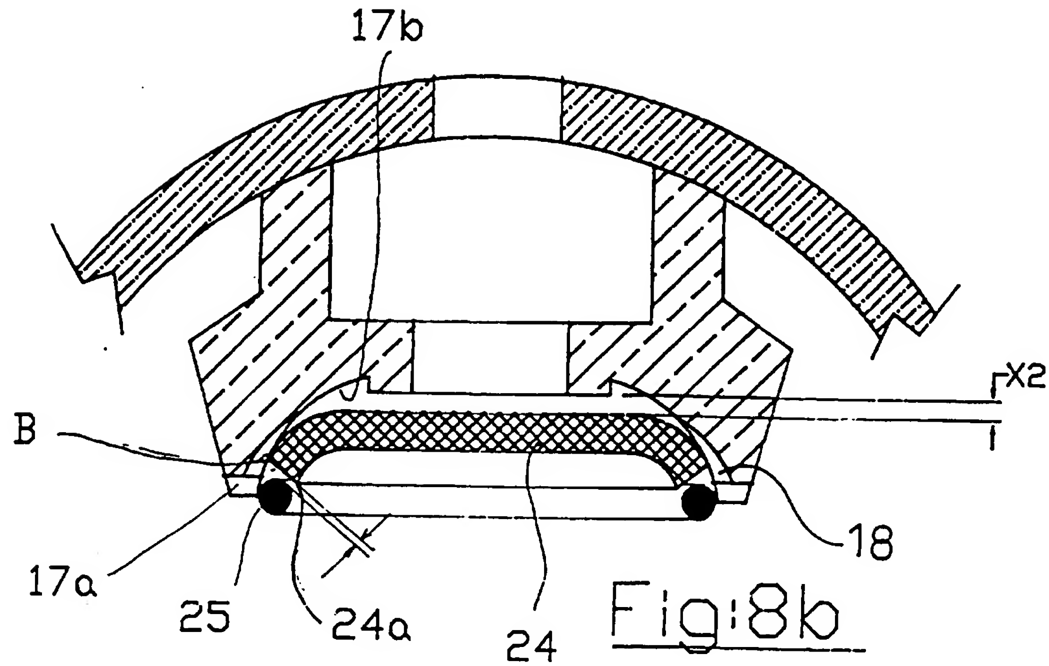

Fig:8b

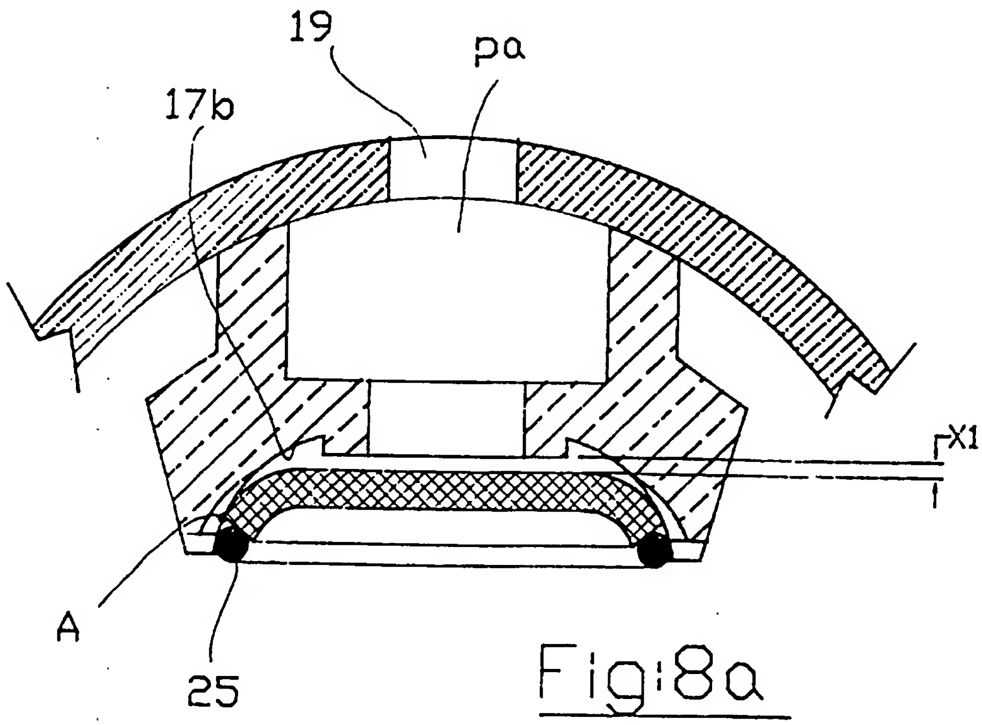

Fig:8a

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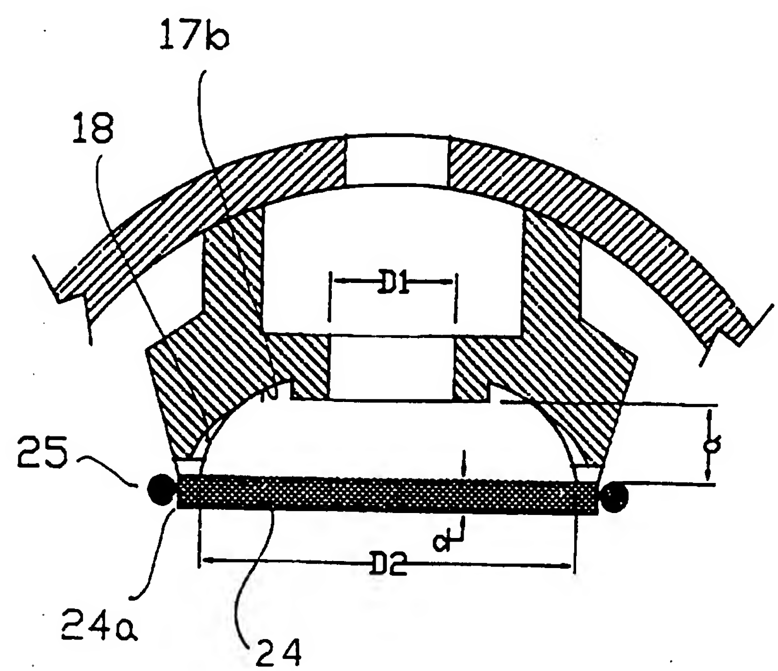

Fig:8c

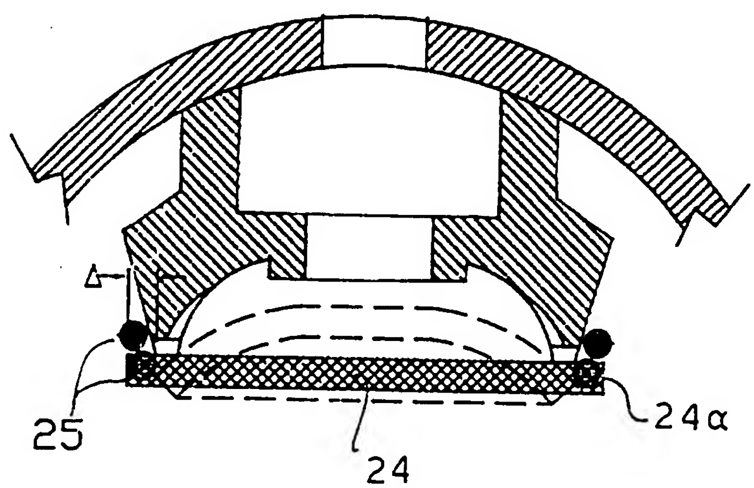

Fig:8d

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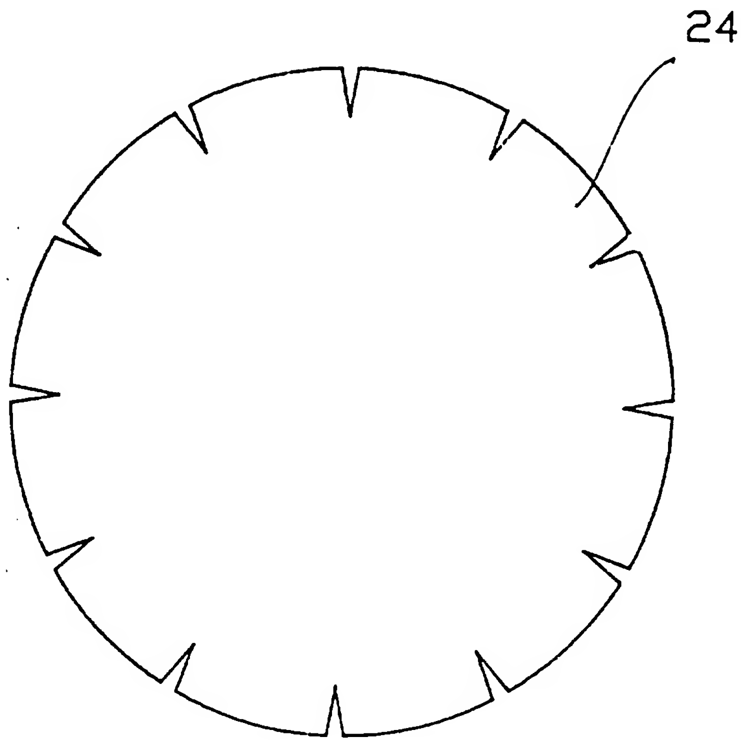
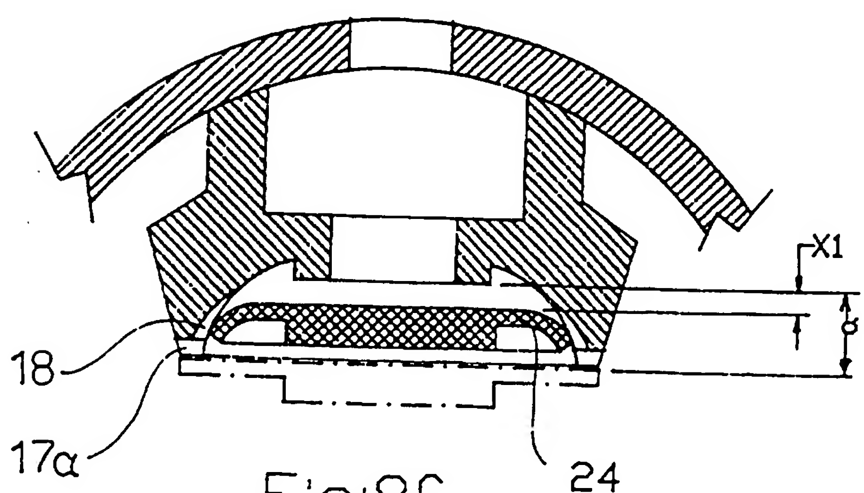


Fig:8e



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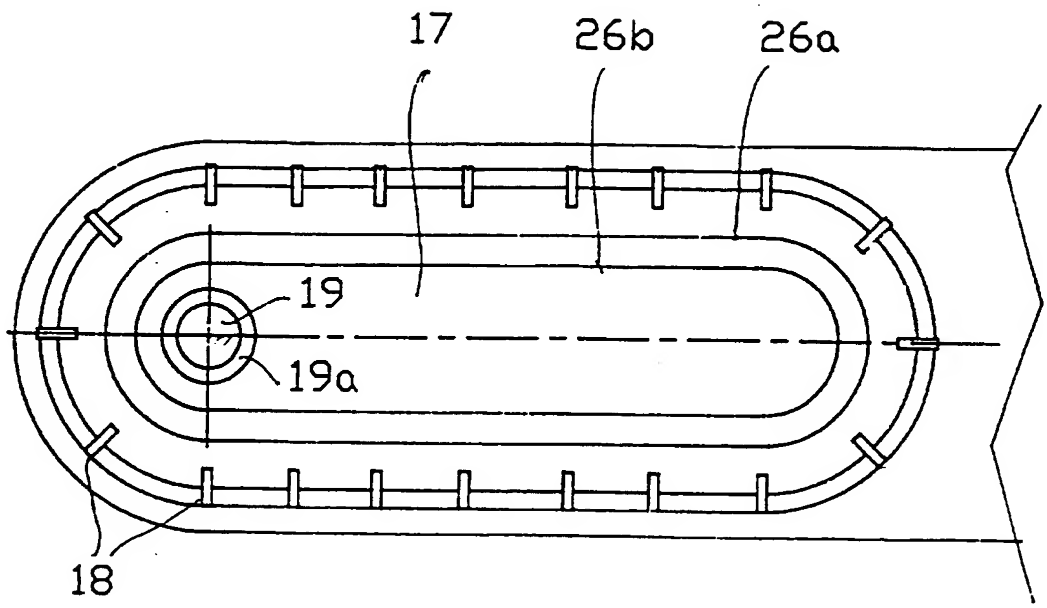

Fig:10a

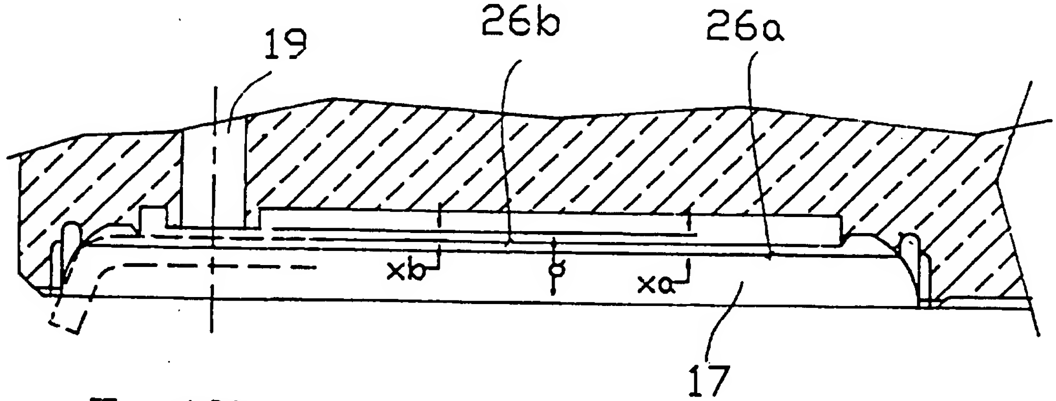

Fig:10b

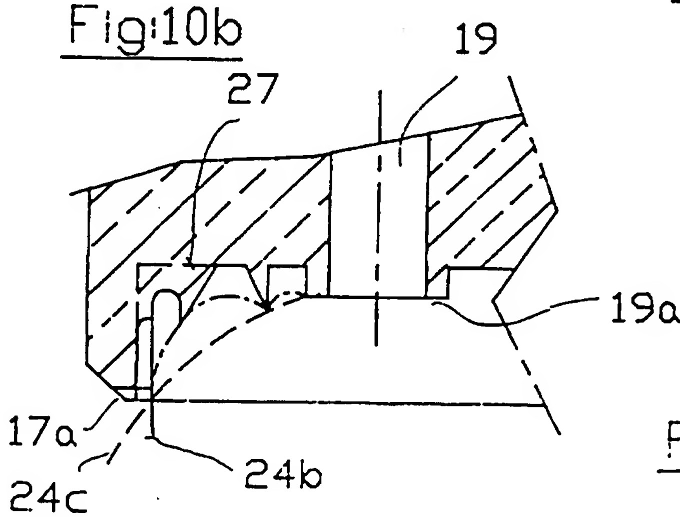

Fig:10c

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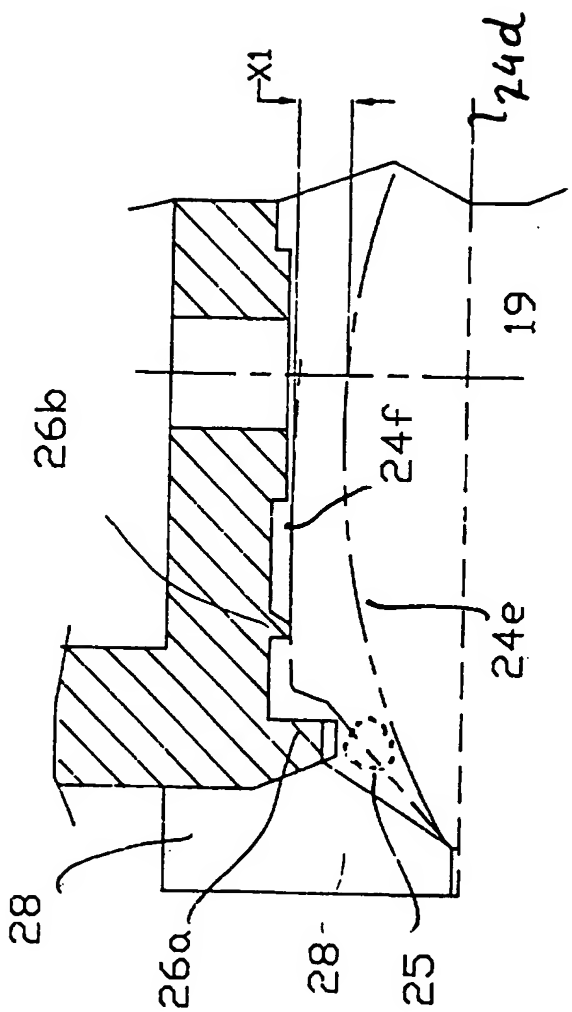

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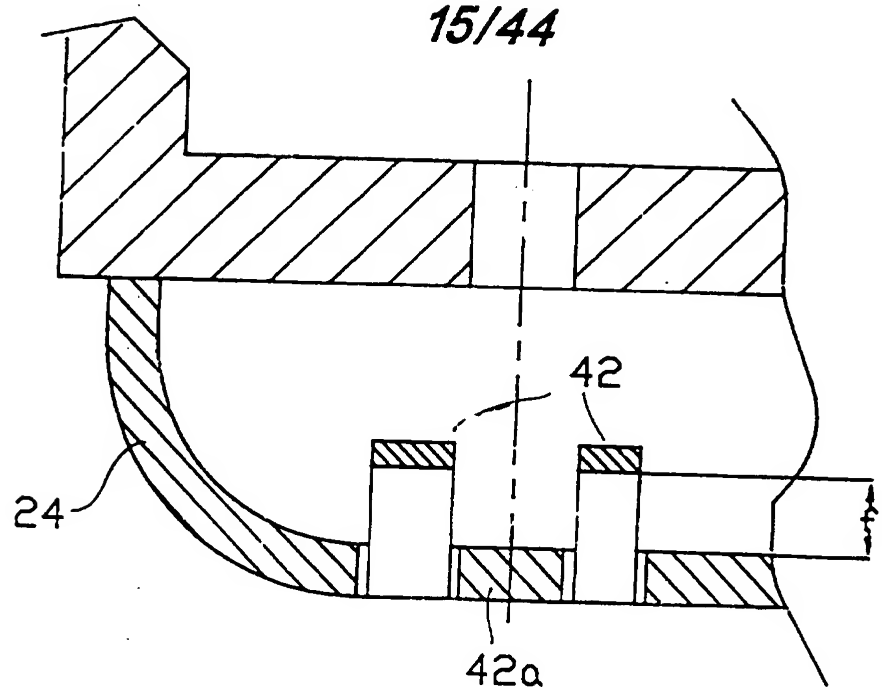

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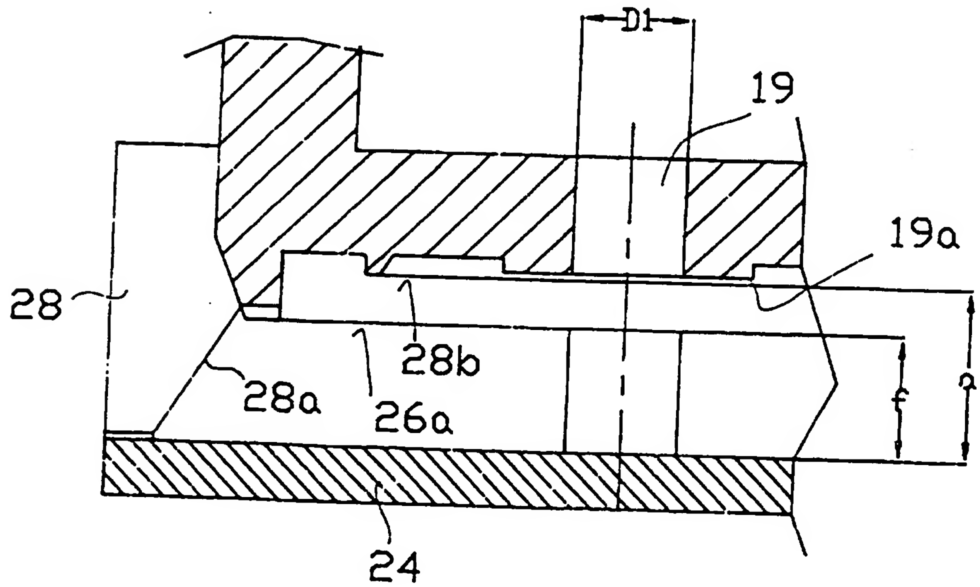

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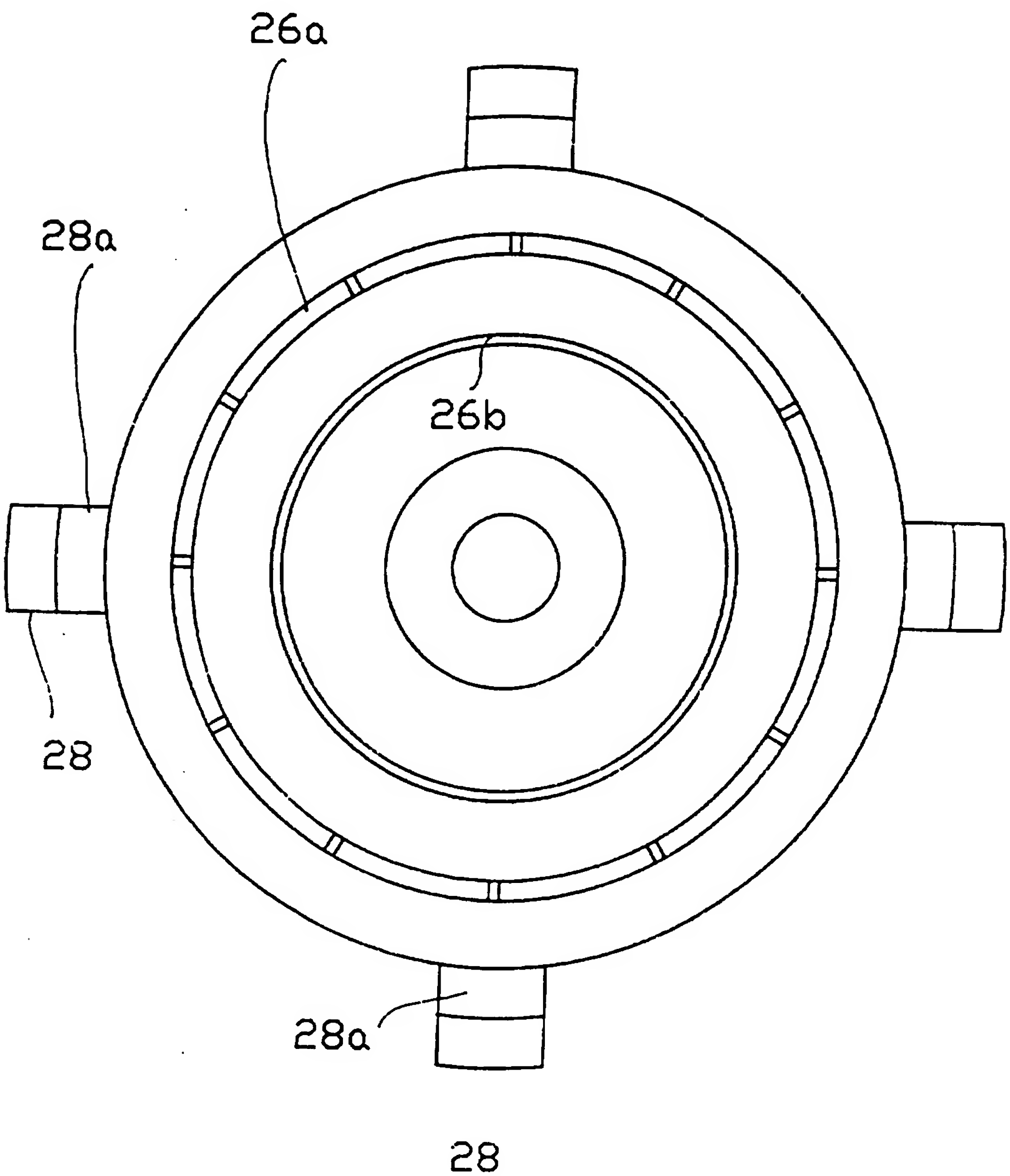

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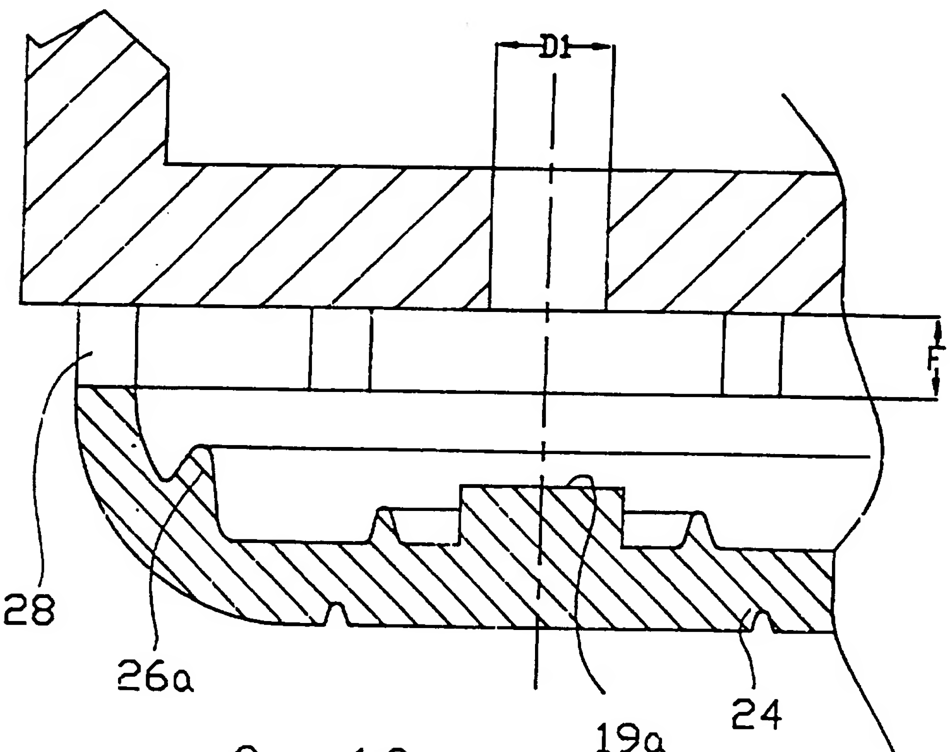

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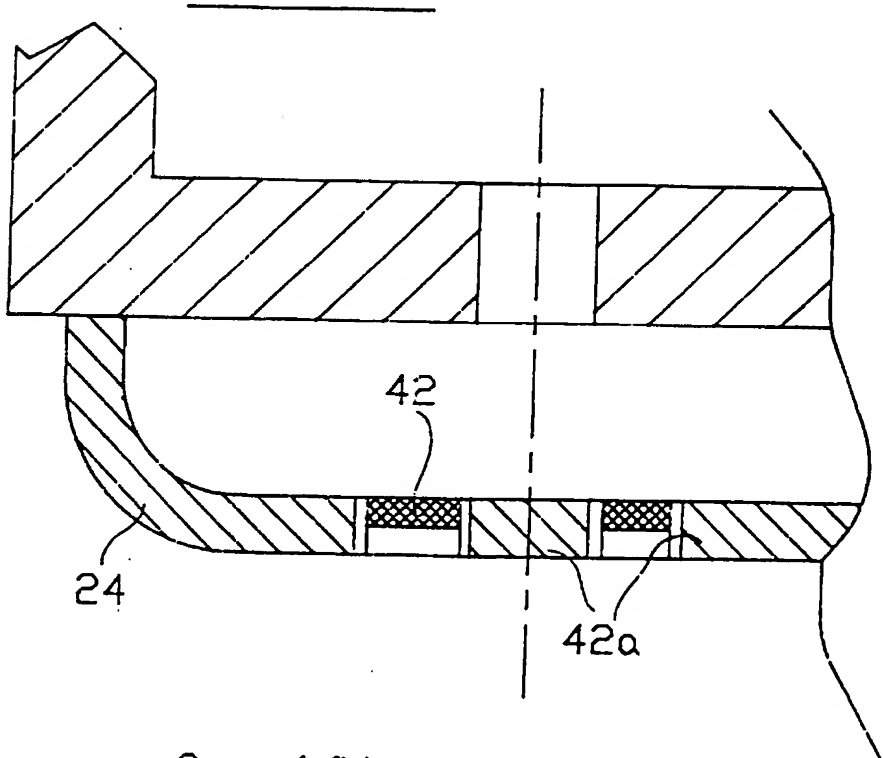

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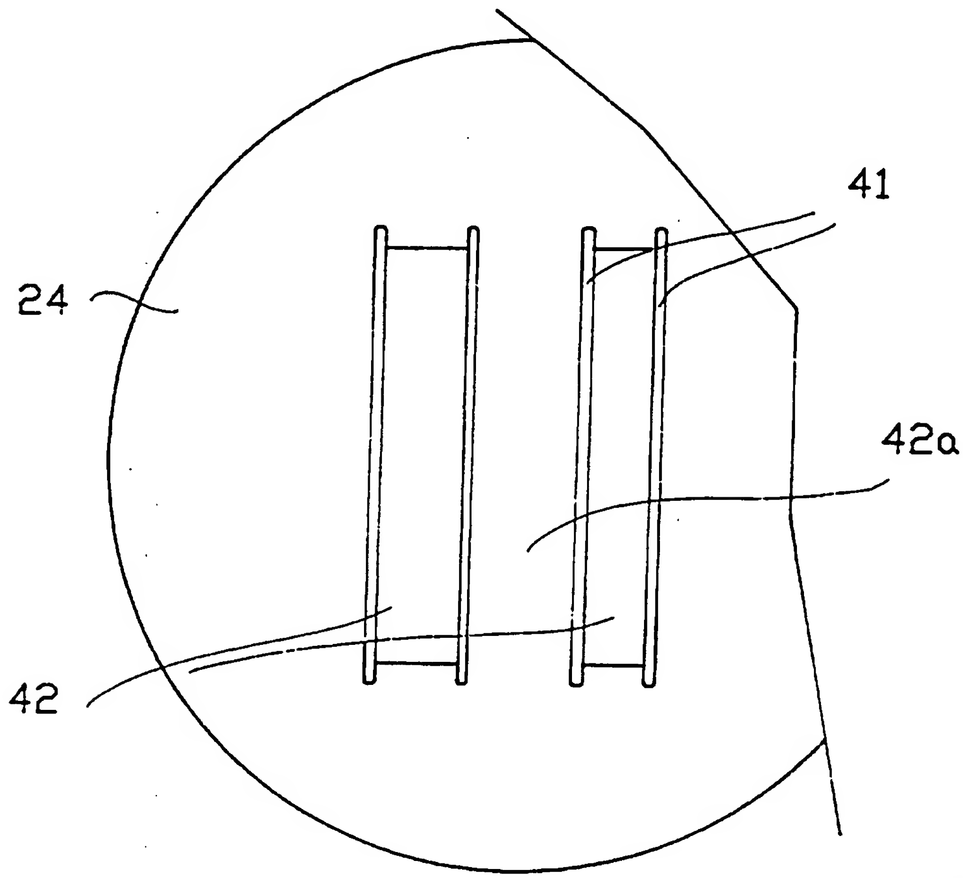

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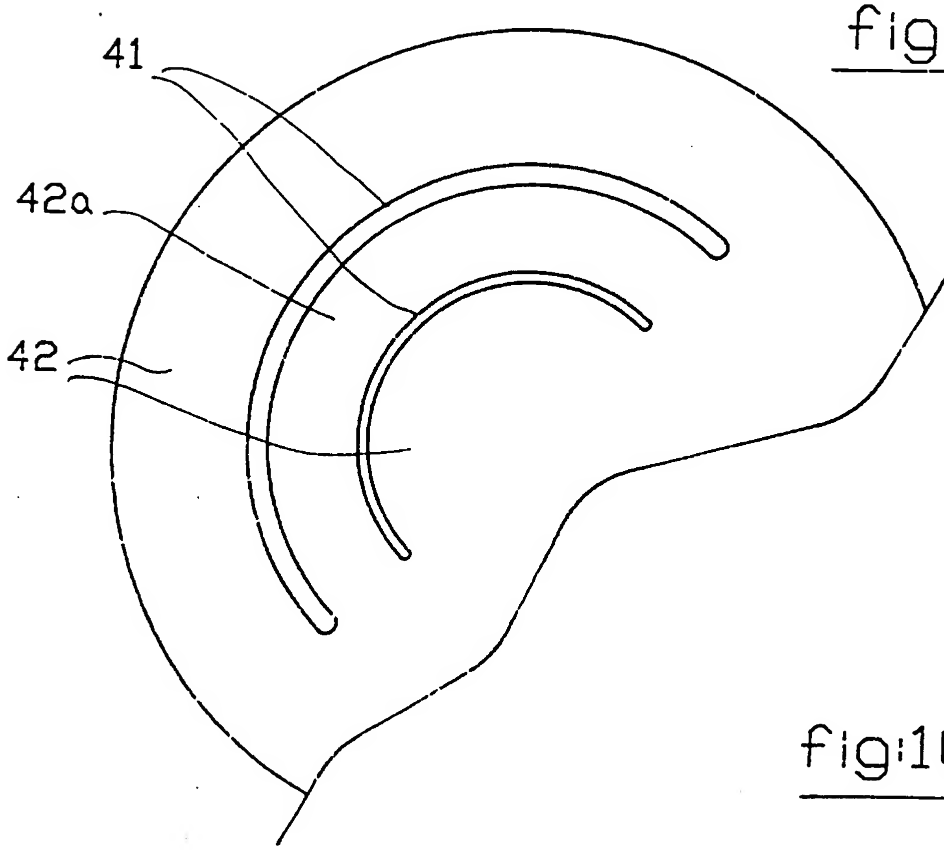

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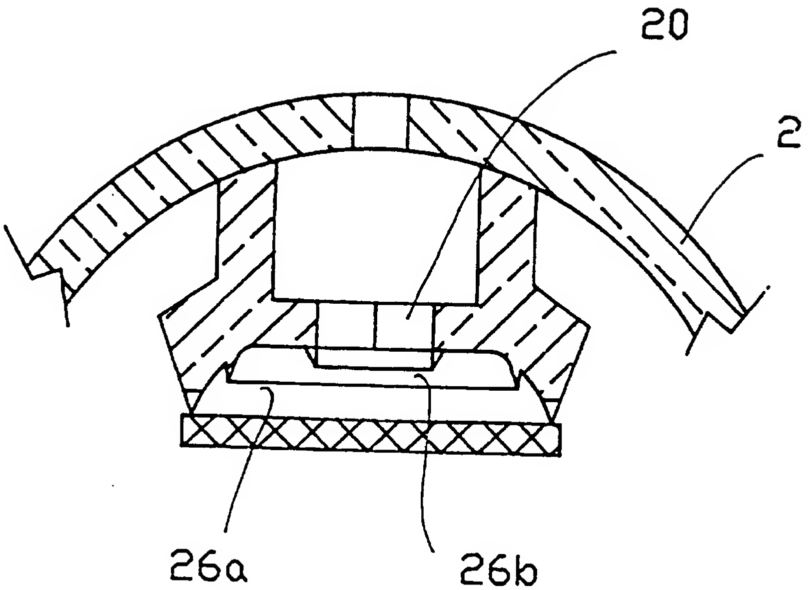

Fig:10n

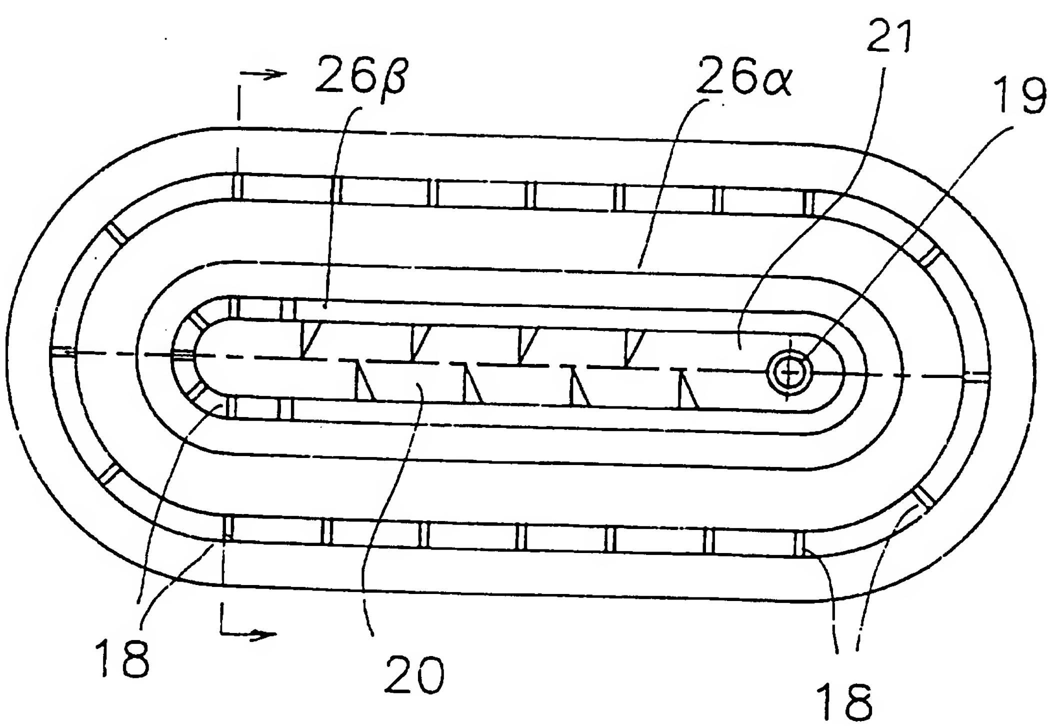

Fig:10m

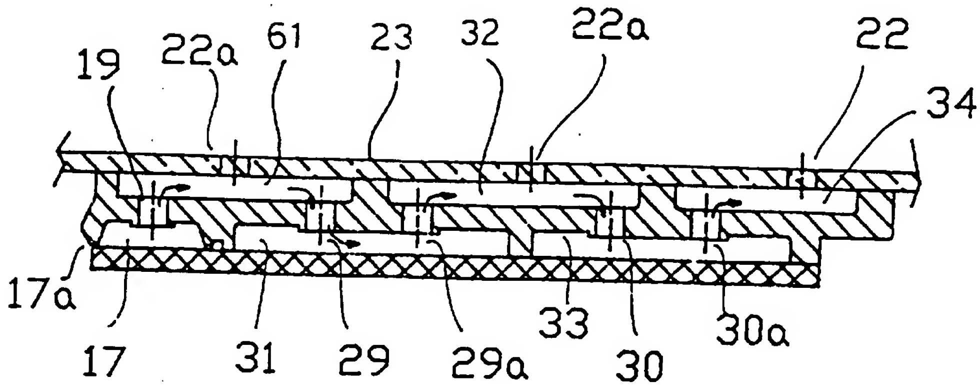

fig:12

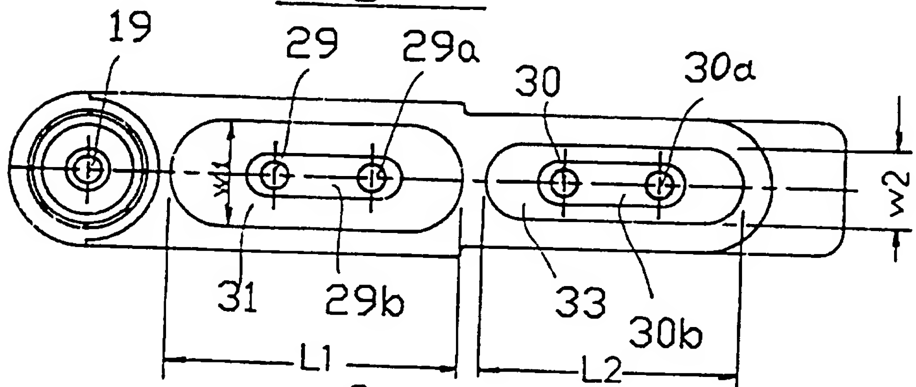

fig:13

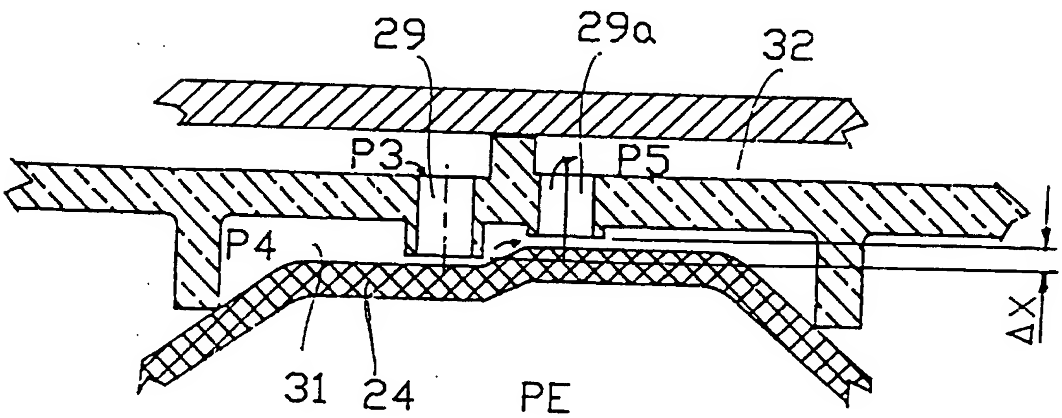

fig:16c

Express Label No.
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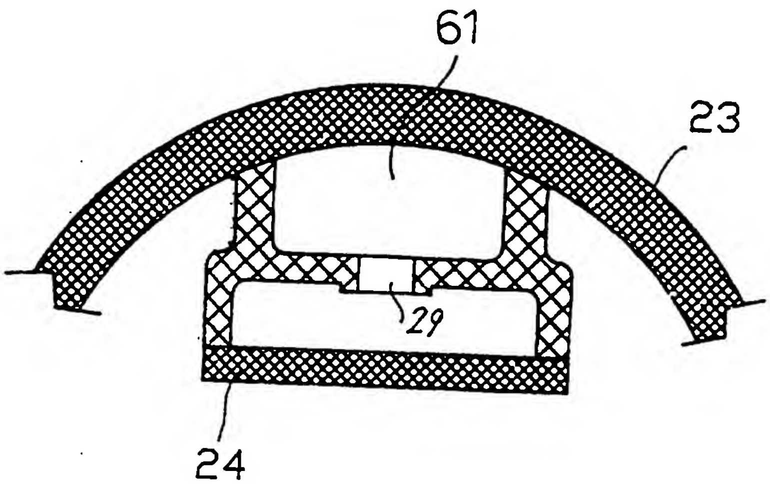

Fig:14

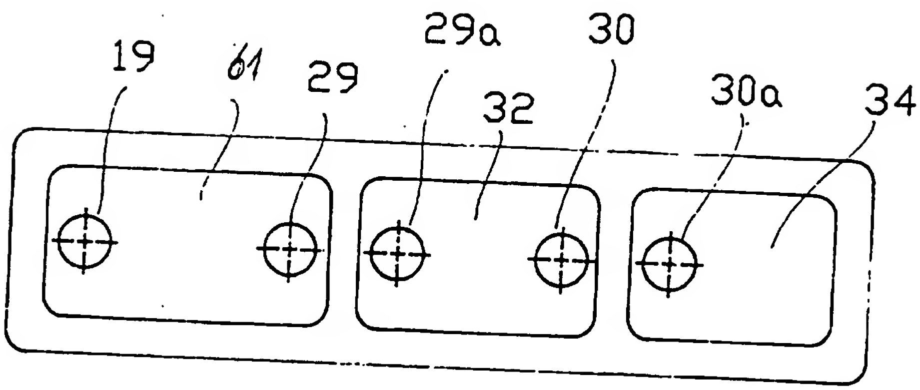

Fig:15

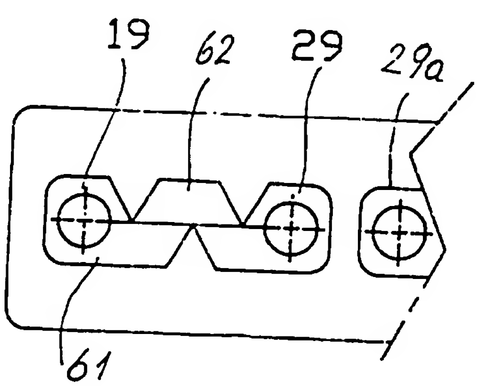

Fig:15a

Express Label No.
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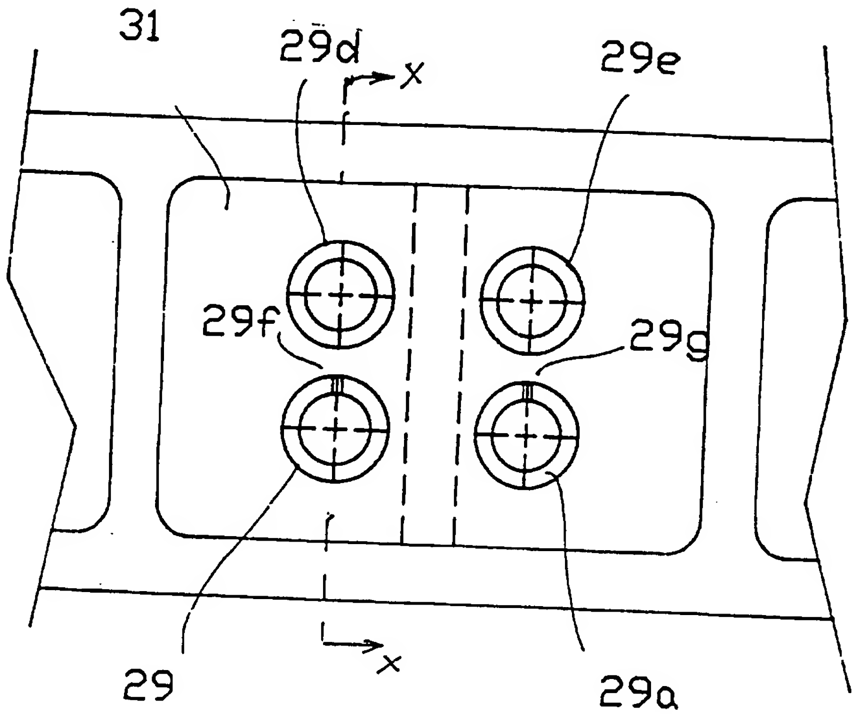

Fig:17

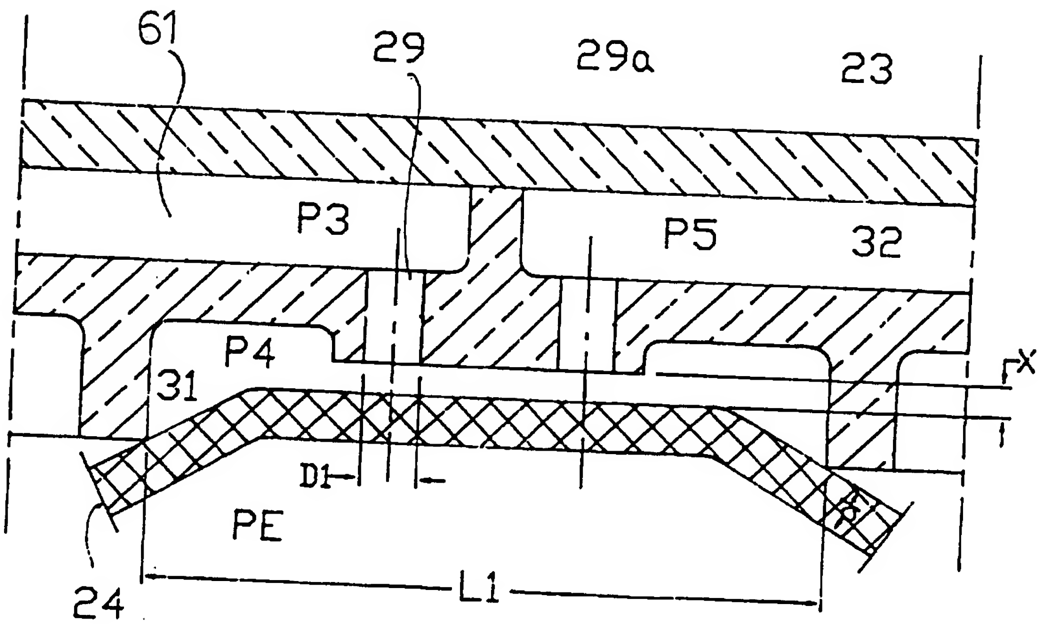

Fig:16

Express Label No.
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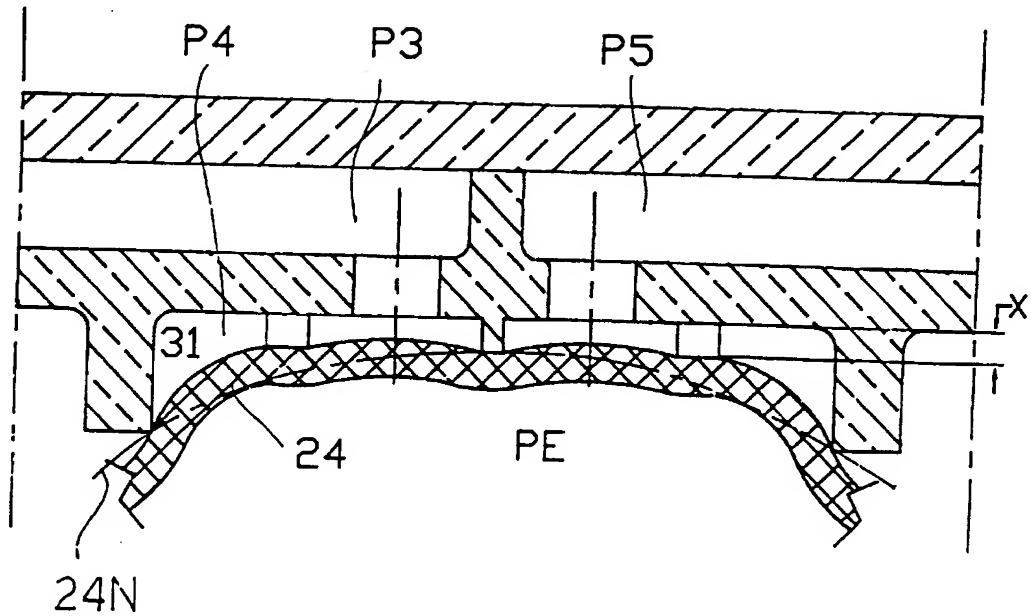

Fig:16a

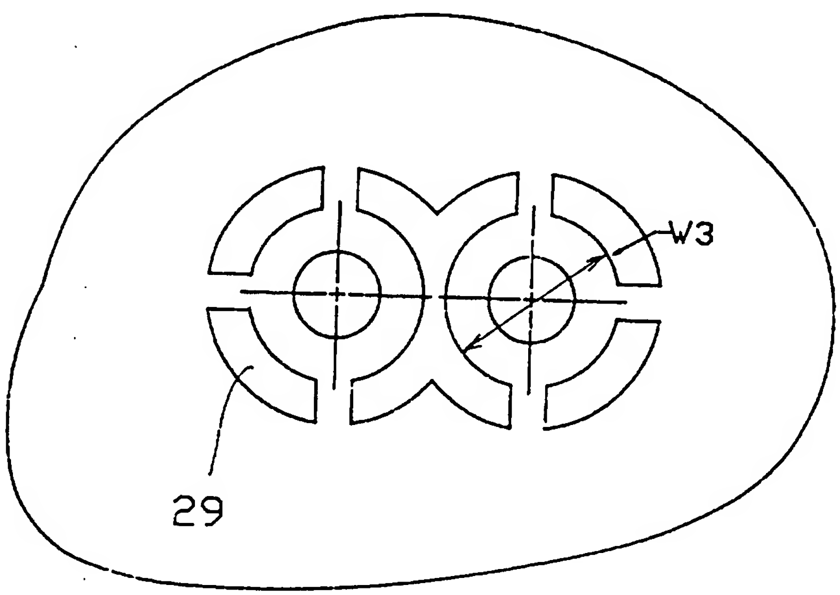

Fig:16b

Express Label No.
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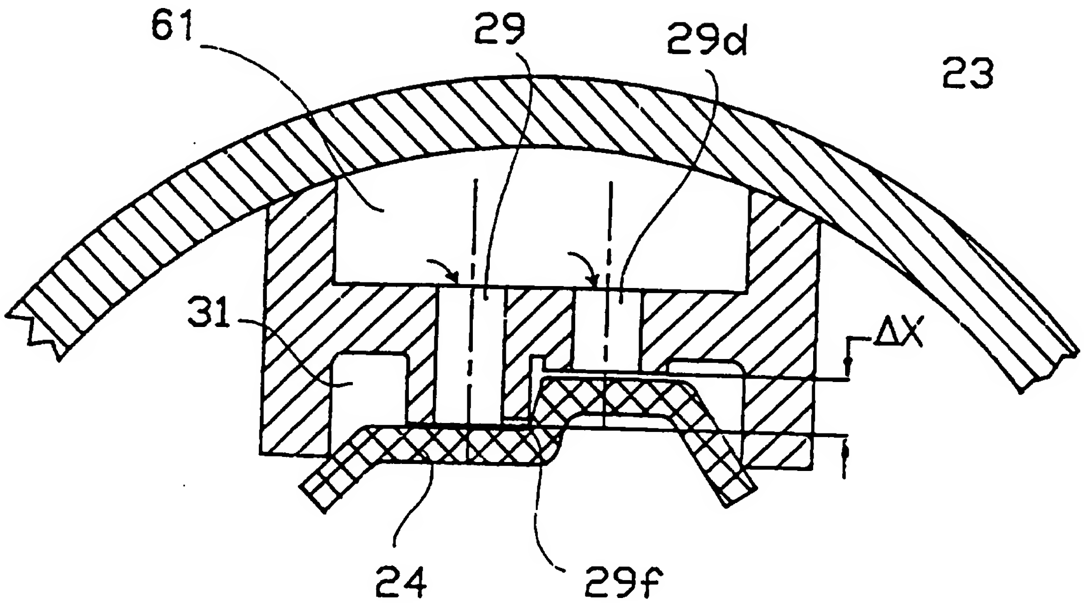

fig:17a

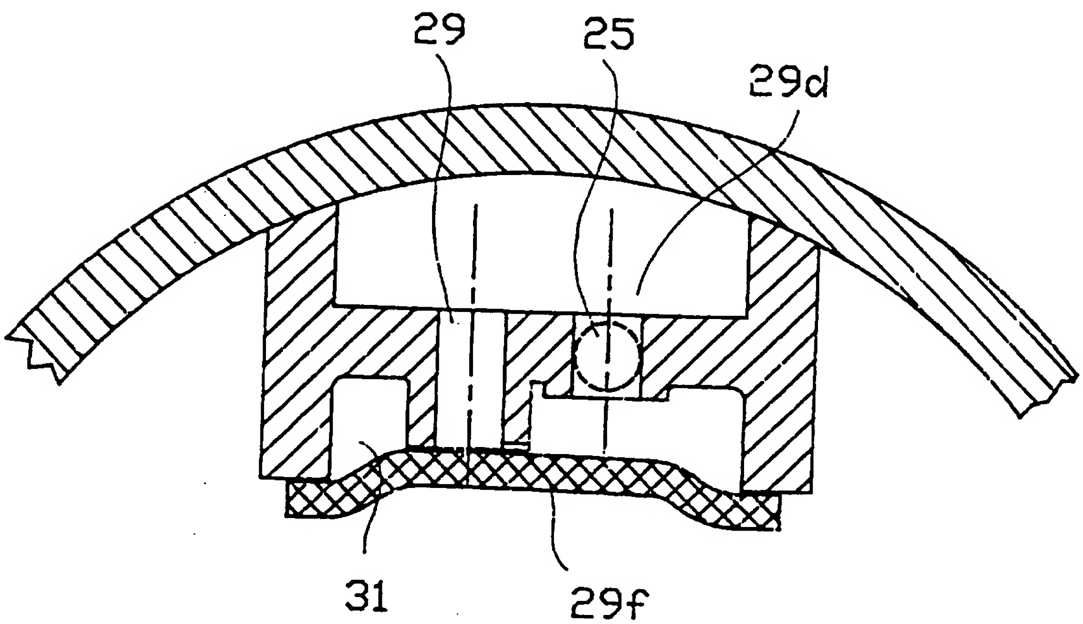

fig:17b

Express Label No.
EV342539854US

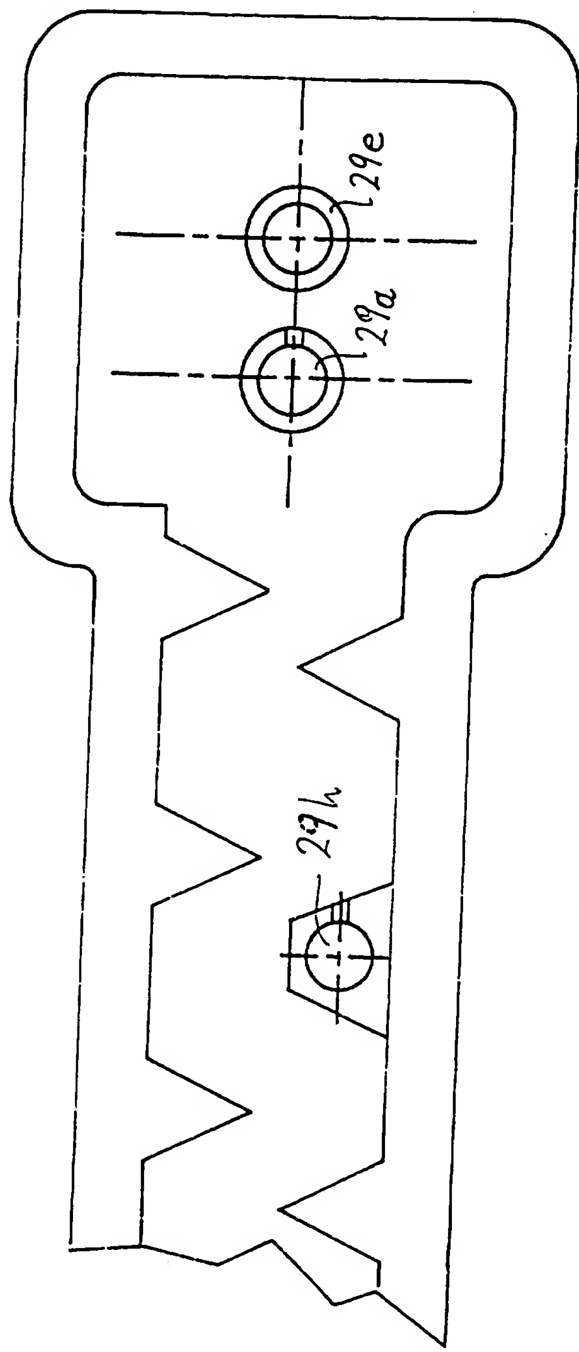

fig:18

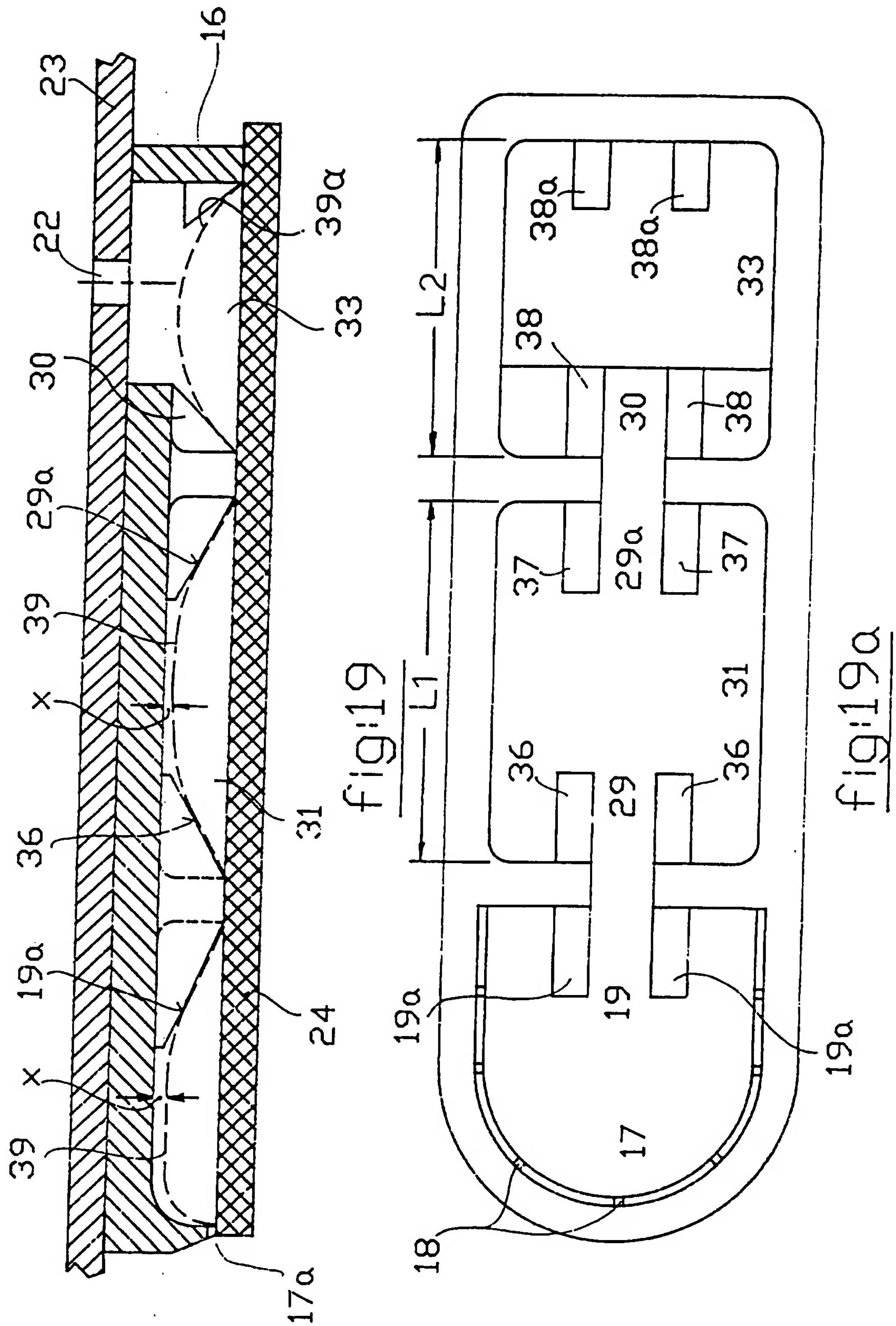

fig:19

fig:19a

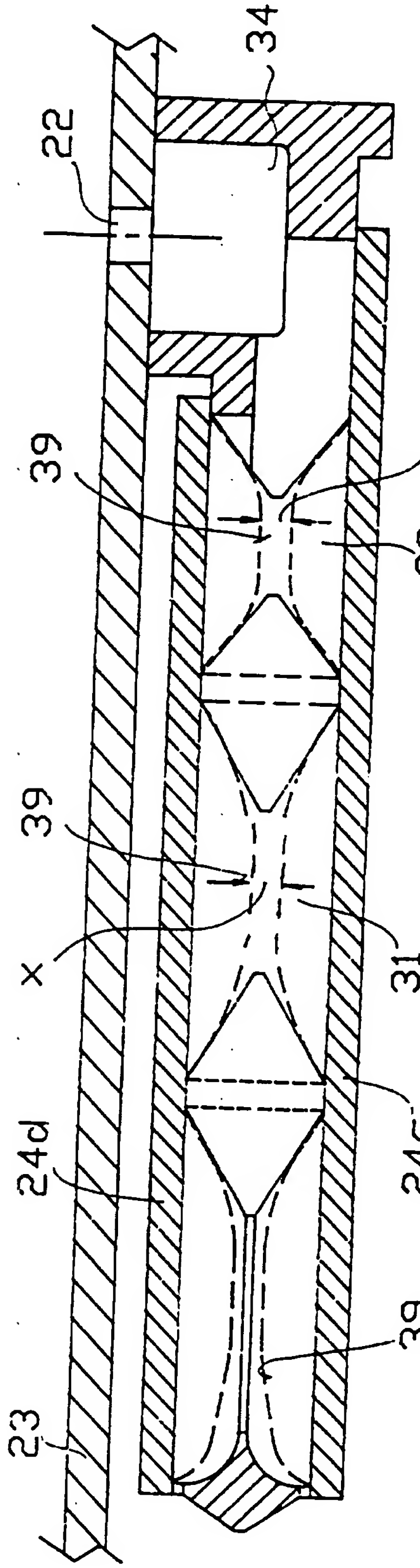

fig.20

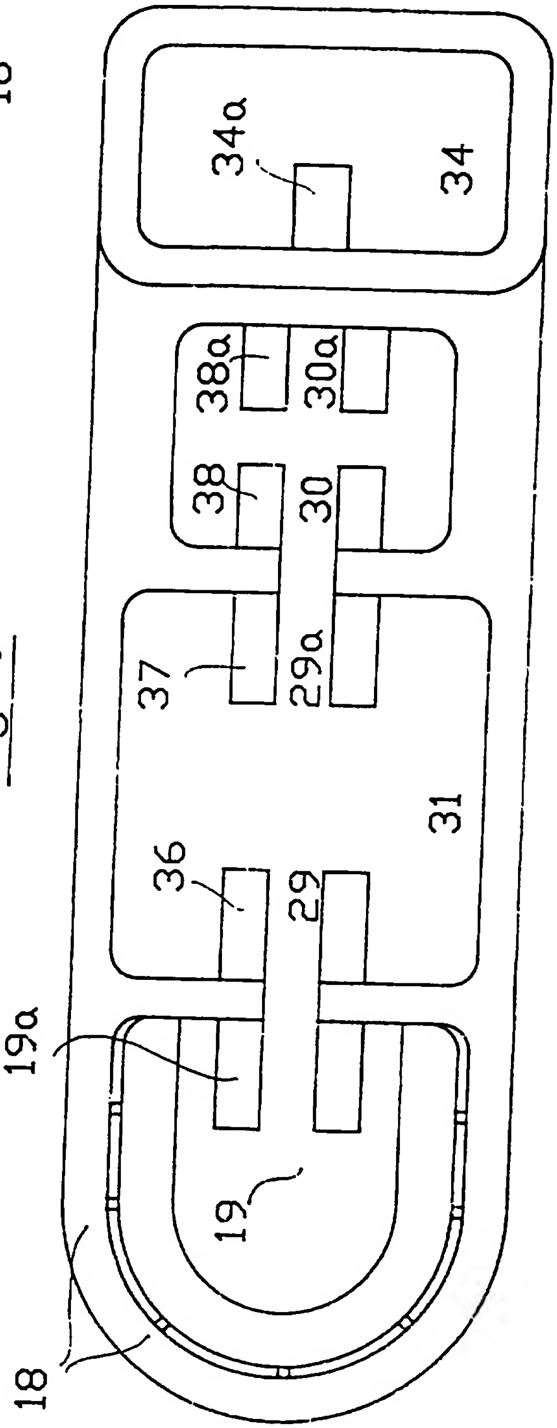

fig.20a

Express Label No.
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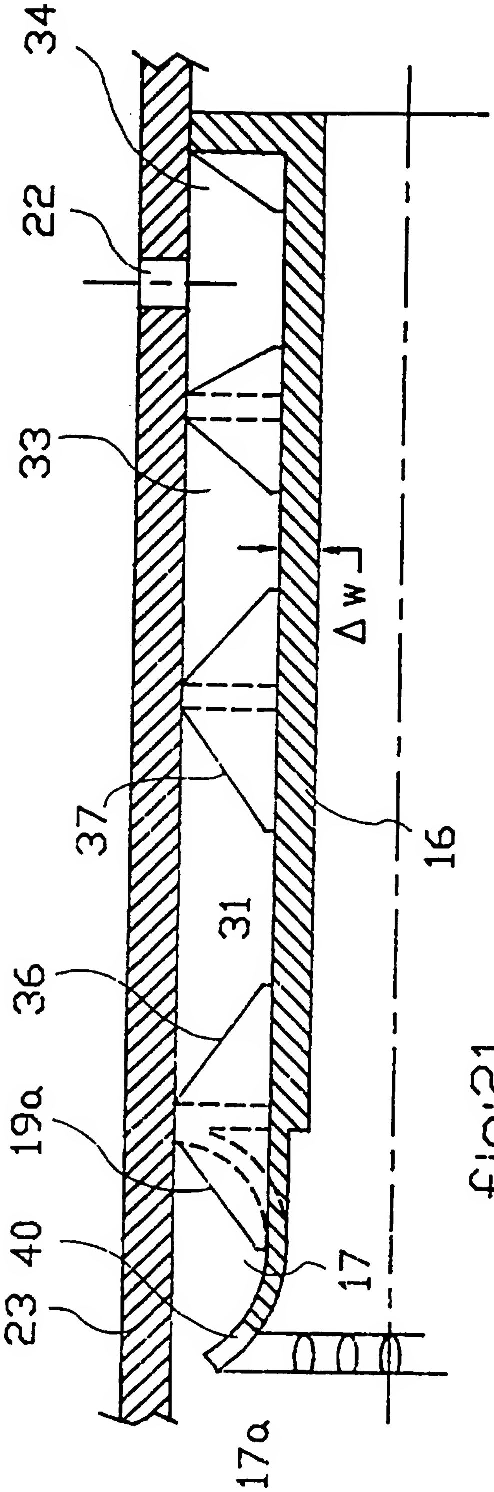

fig:21

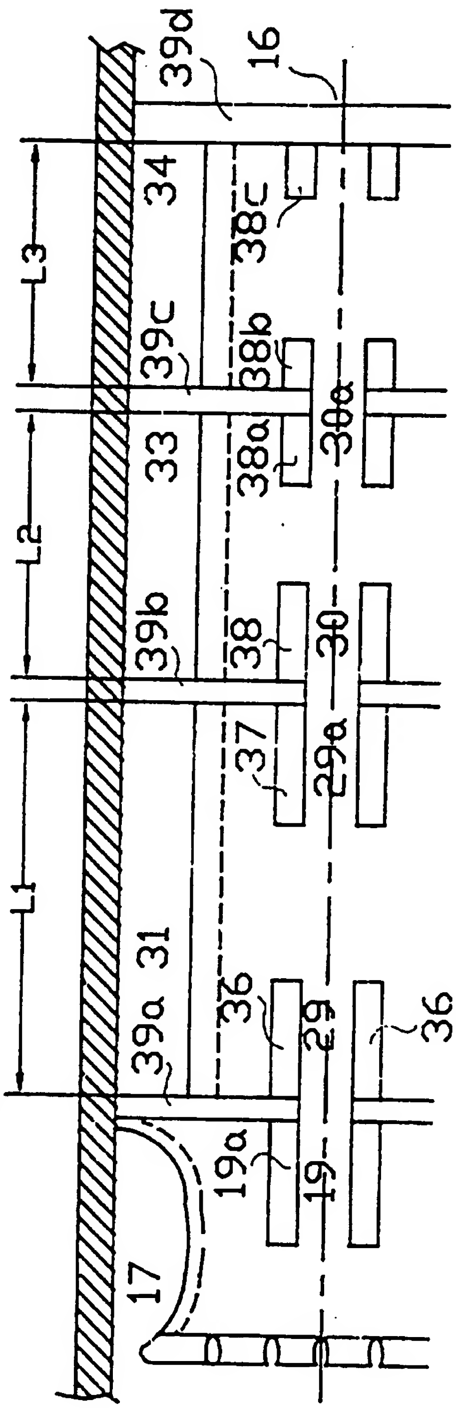

fig:21a

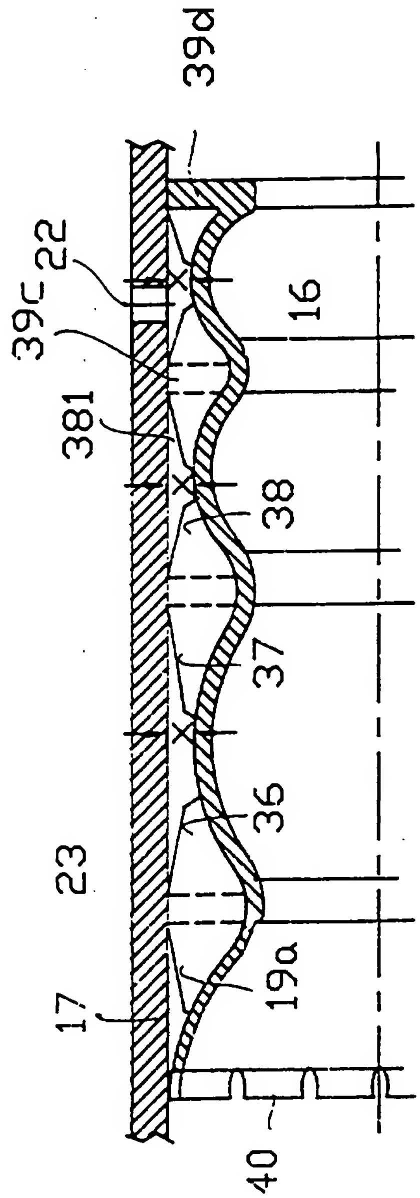

FIG:21B

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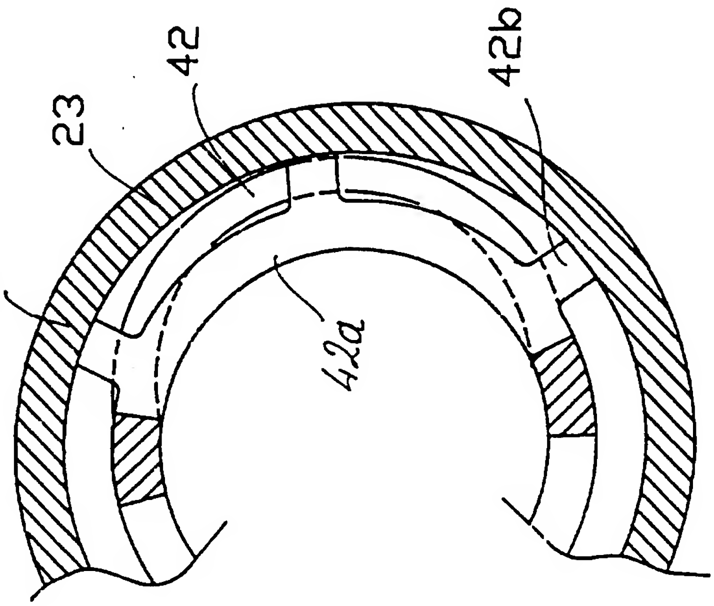

FIG:21d

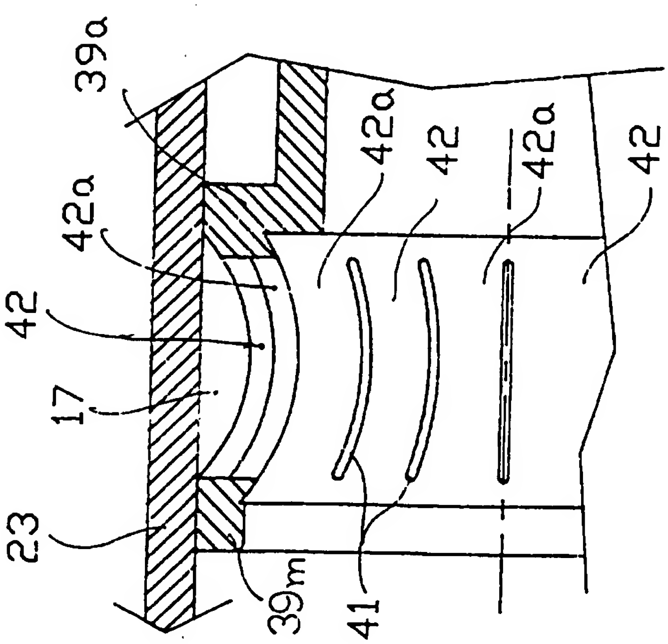

FIG:21C

Express Label No.
EV342539854US

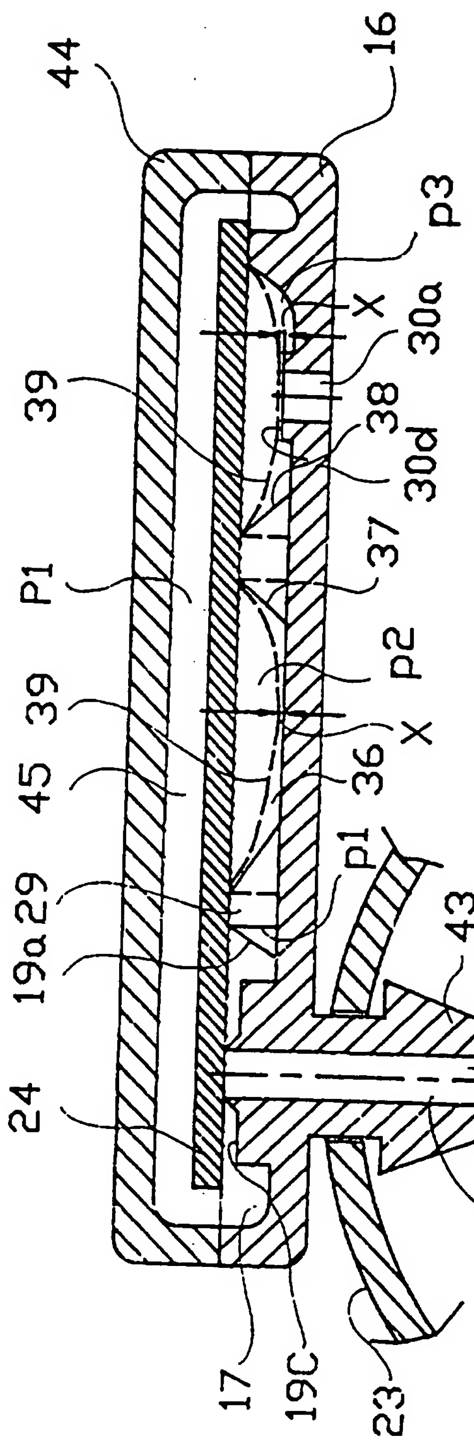

fig:22

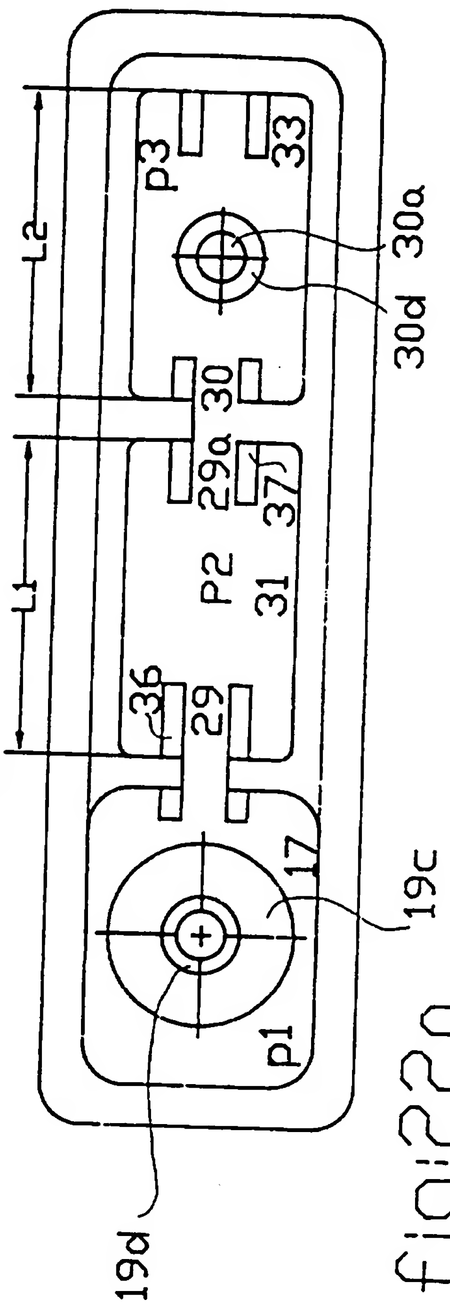

fig:22a

Express Label No.
EV342539854US

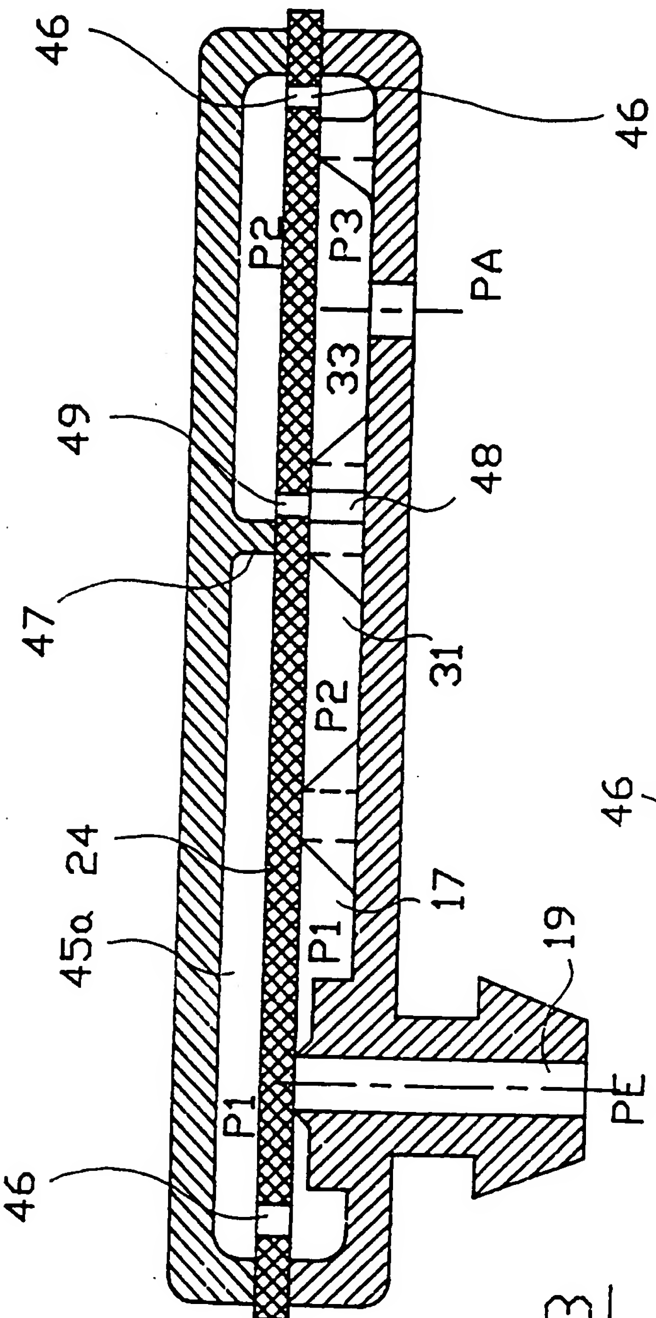

fig:23

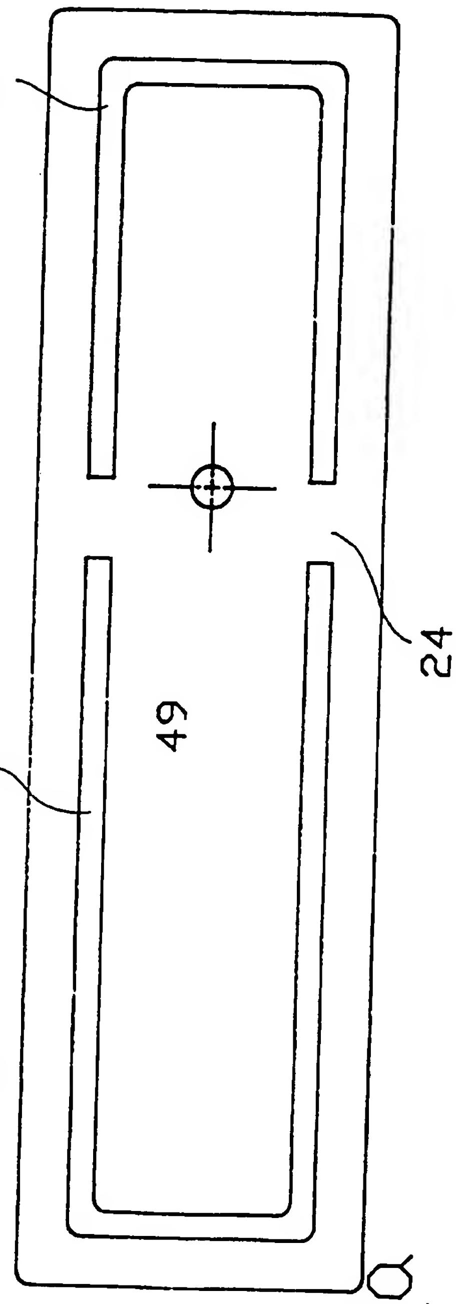

fig:23a

Express Label No.
EV342539854US

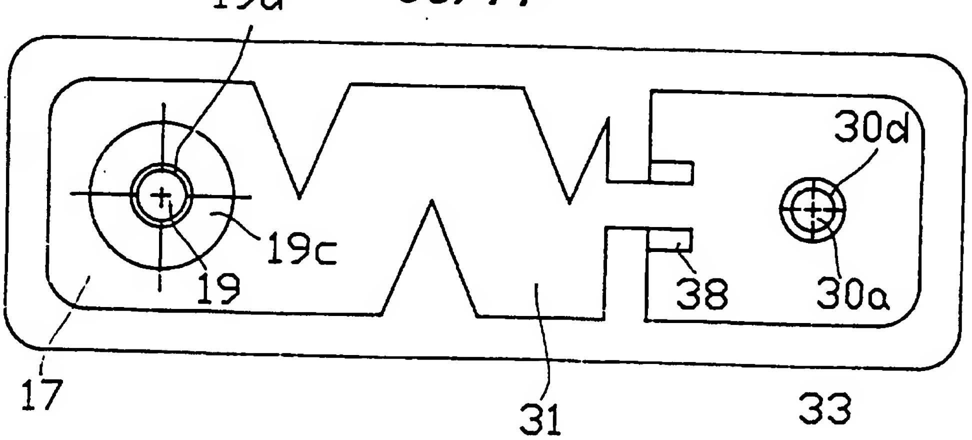

fig:24

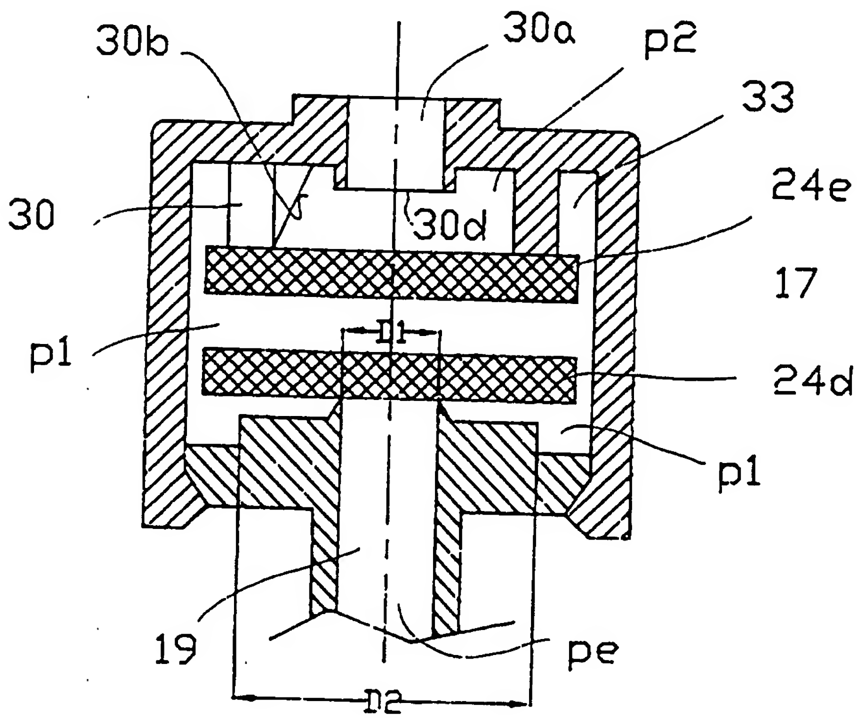

Fig:25

Express Label No.
EV342539854US

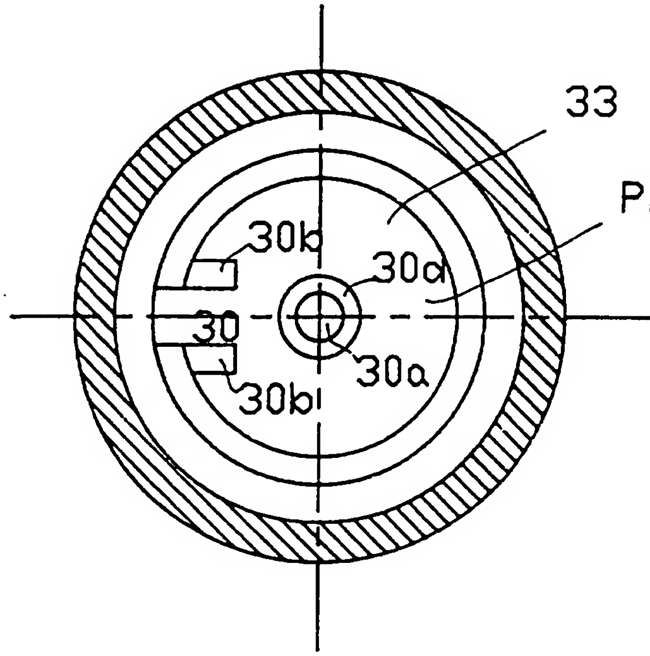

Fig:25a

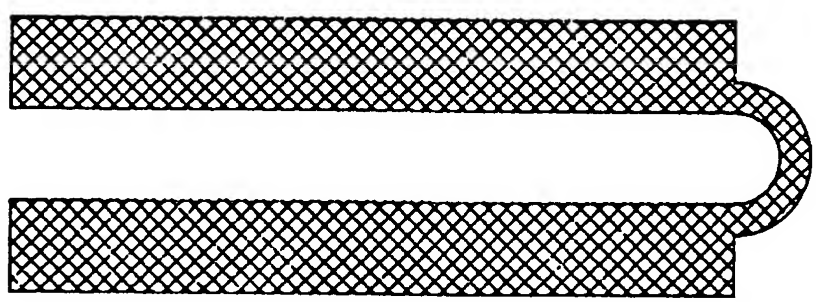

Fig:25b

Express Label No.
EV342539854US

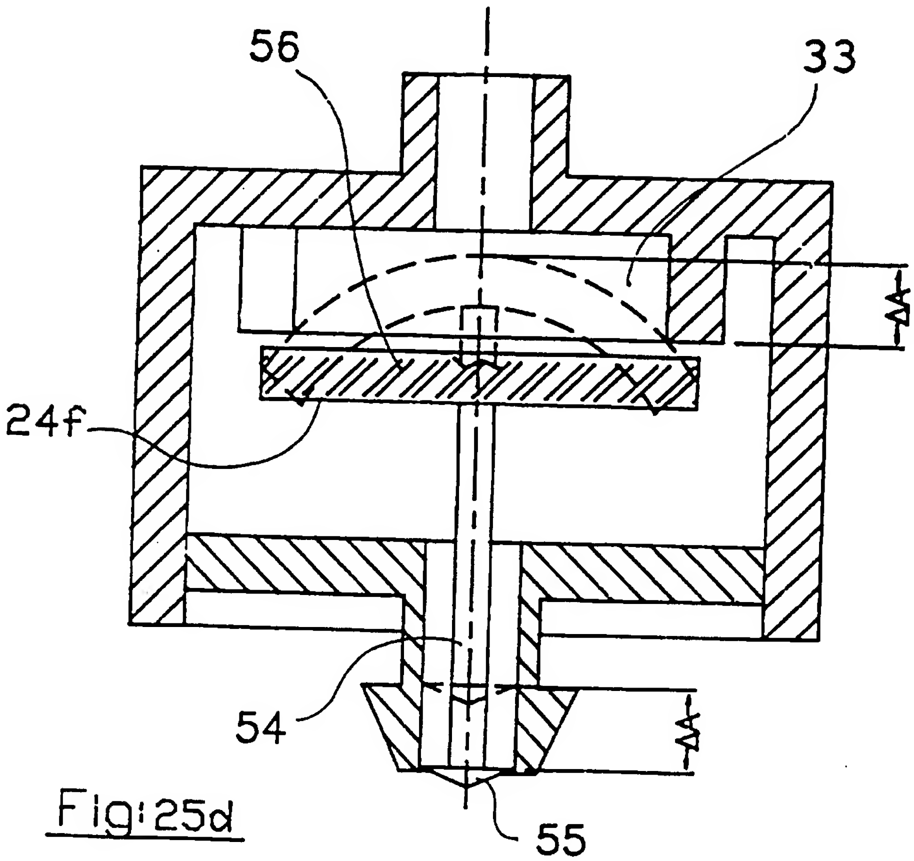

Fig:25d

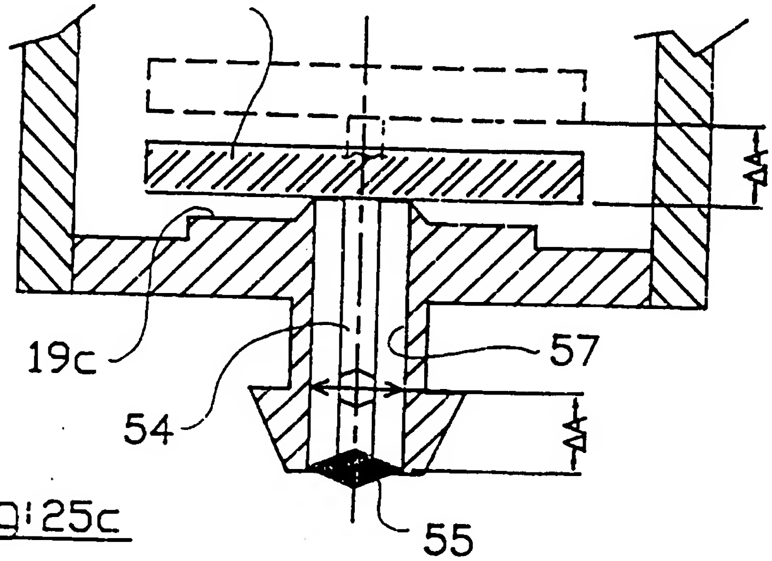

Fig:25c

Express Label No.
EV342539854US

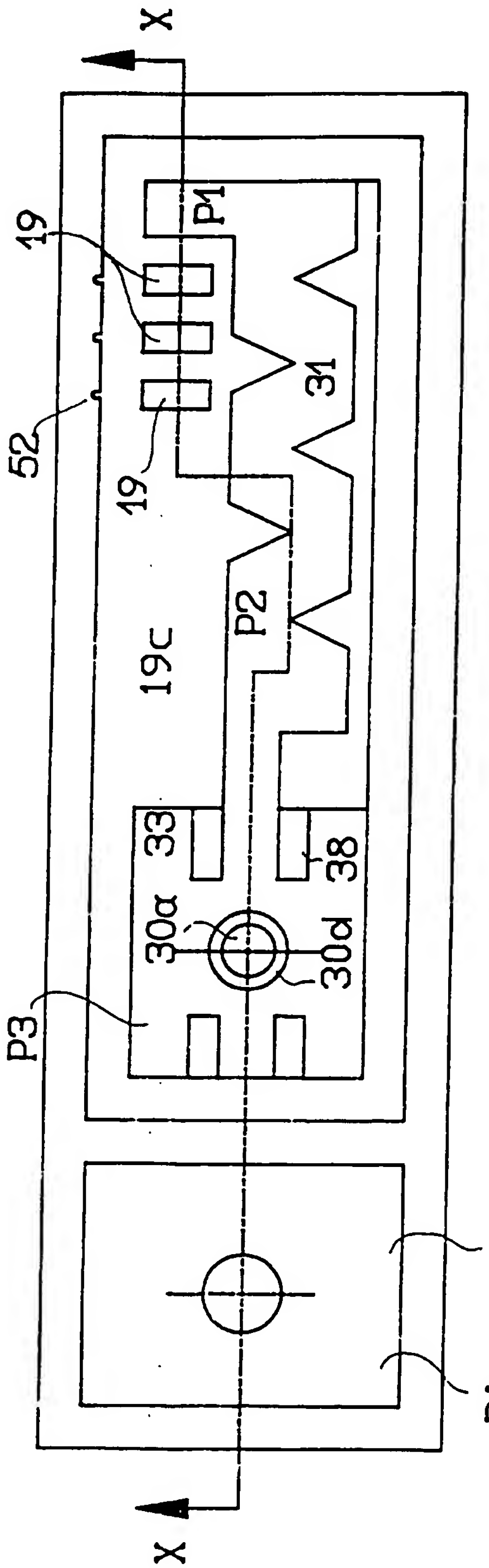

Fig.26

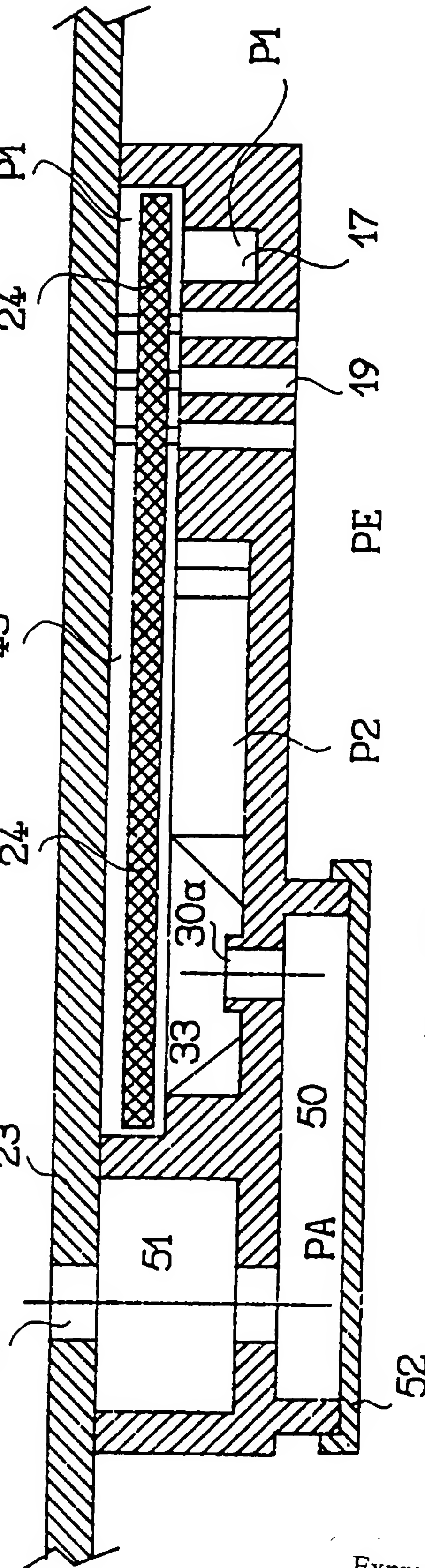

Fig.26α

Express Label No.
EV342539854US

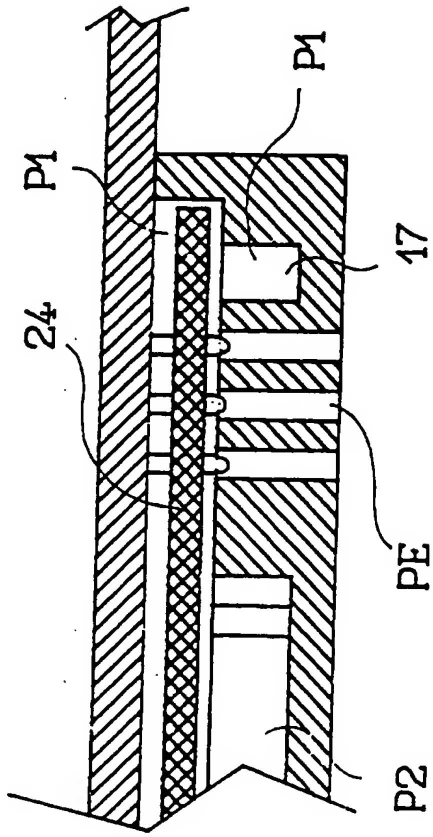

Fig:26c

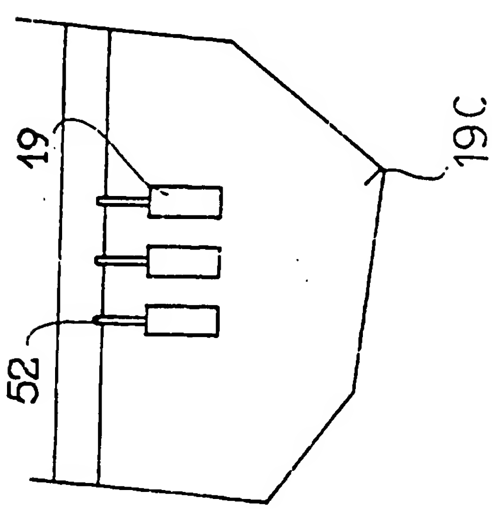

Fig:26b

Express Label No.
EV342539854US

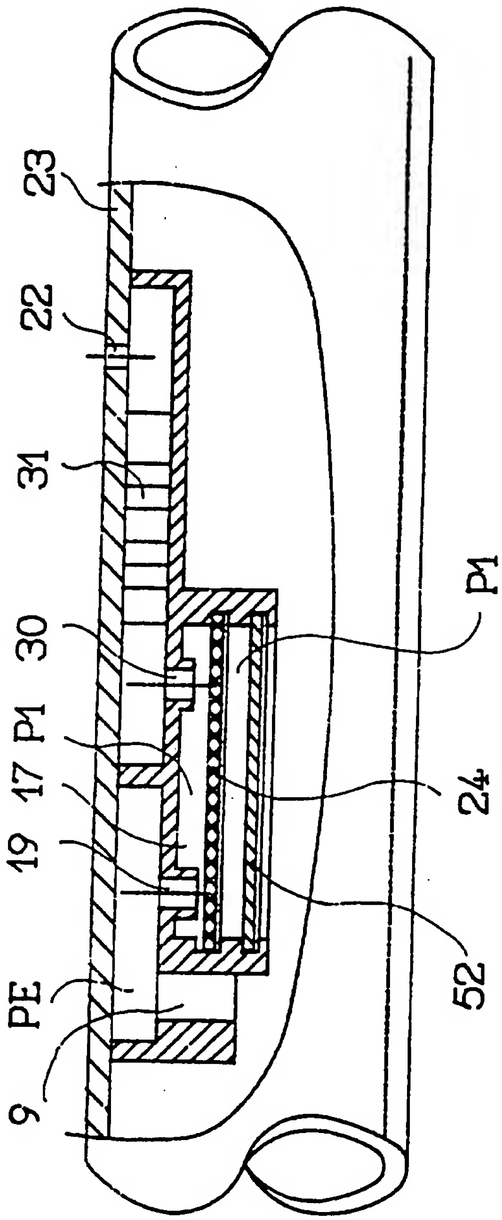

Fig:27

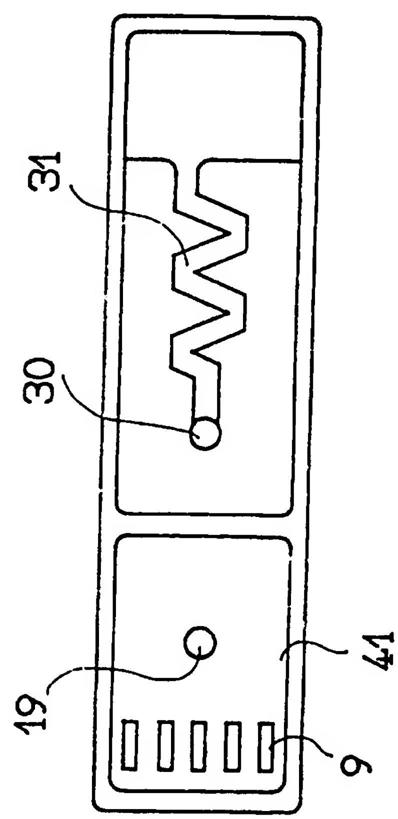

Fig:27a

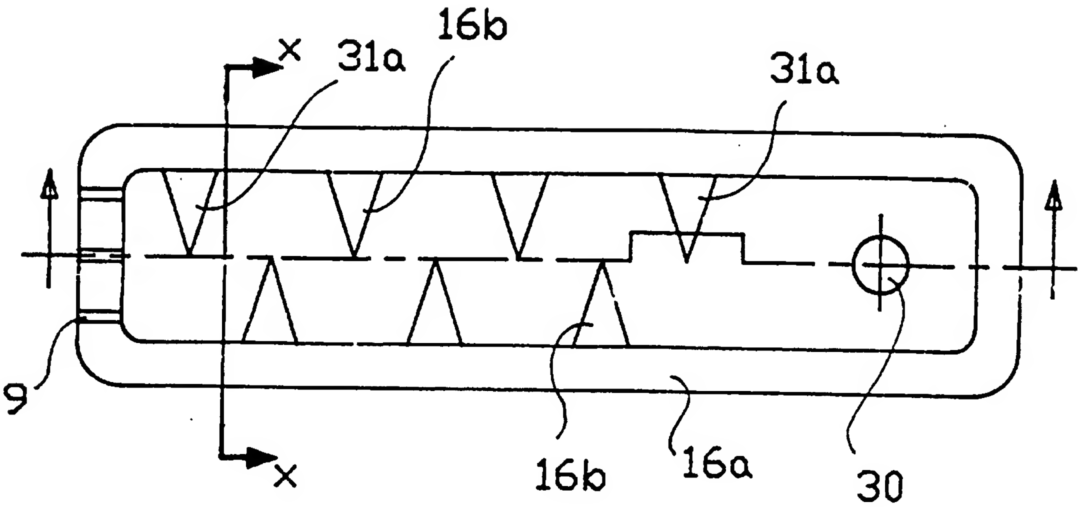

fig:28

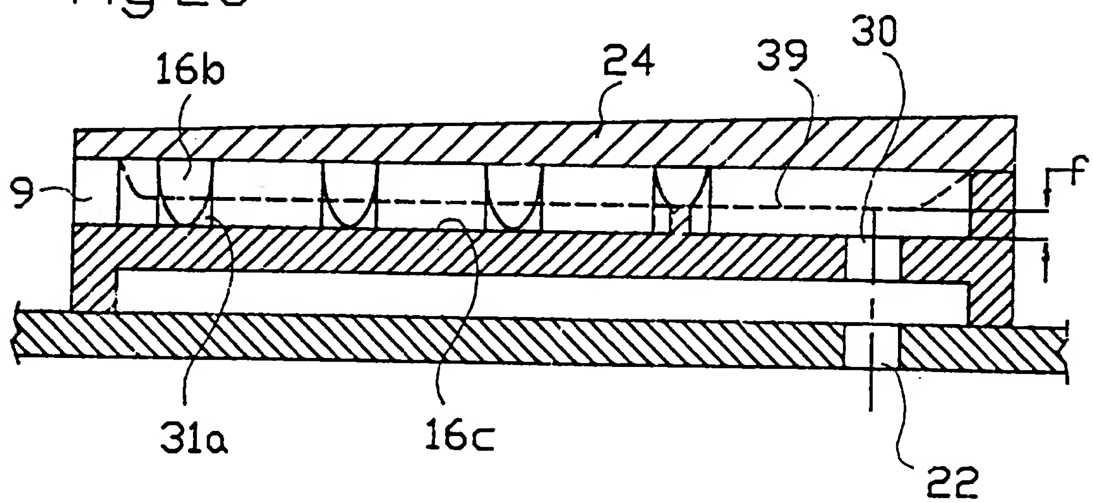

fig:28a

Express Label No.
EV342539854US

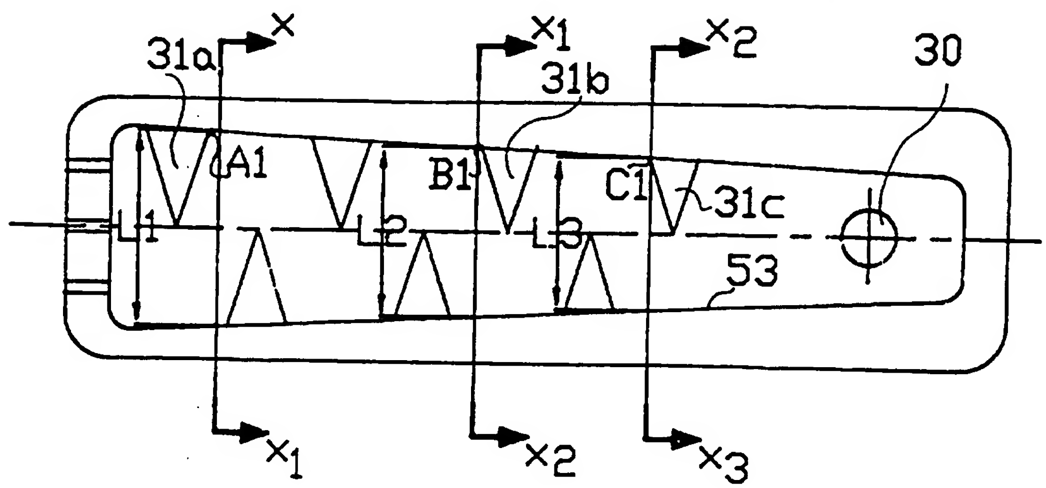

fig:29

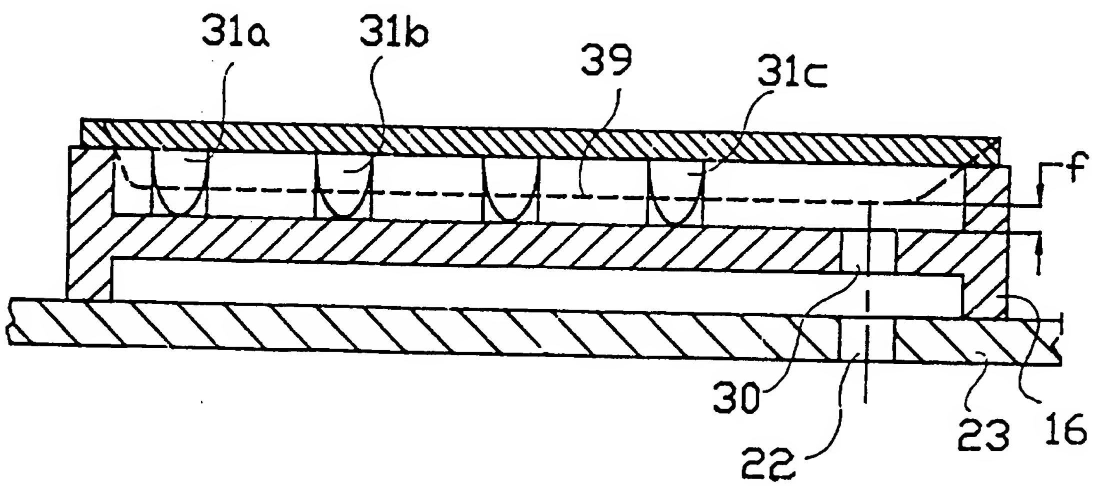

fig:29a

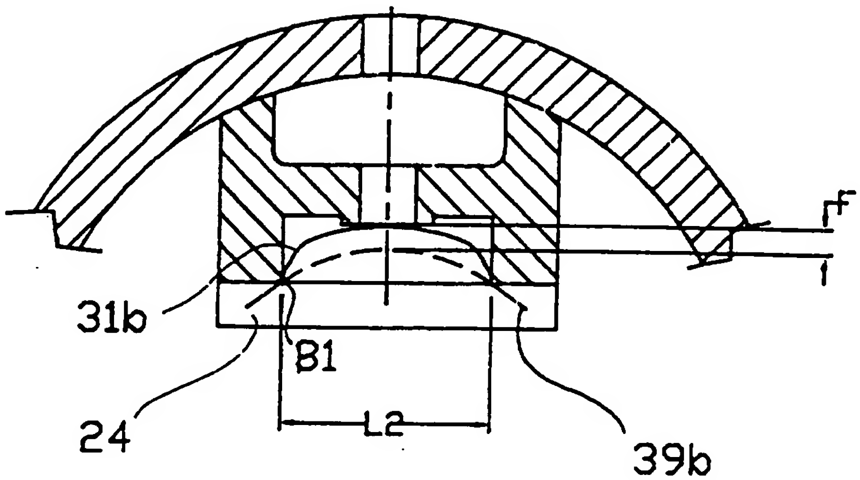

Fig:29c

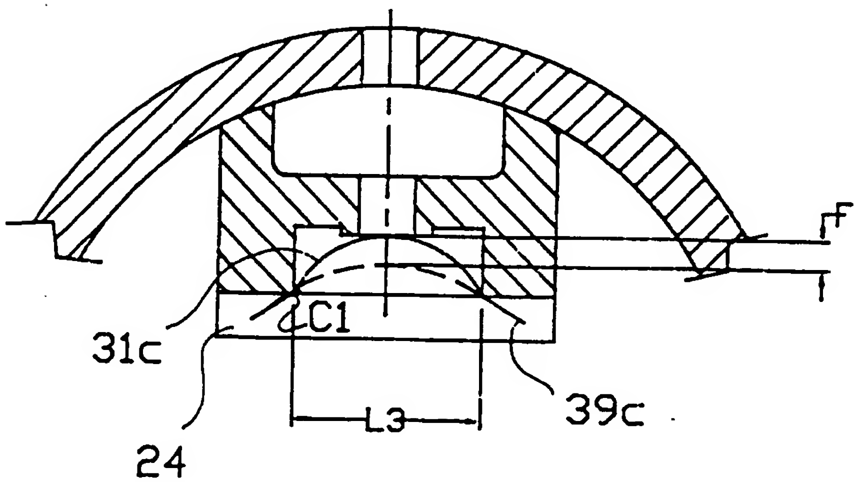

Fig:29d

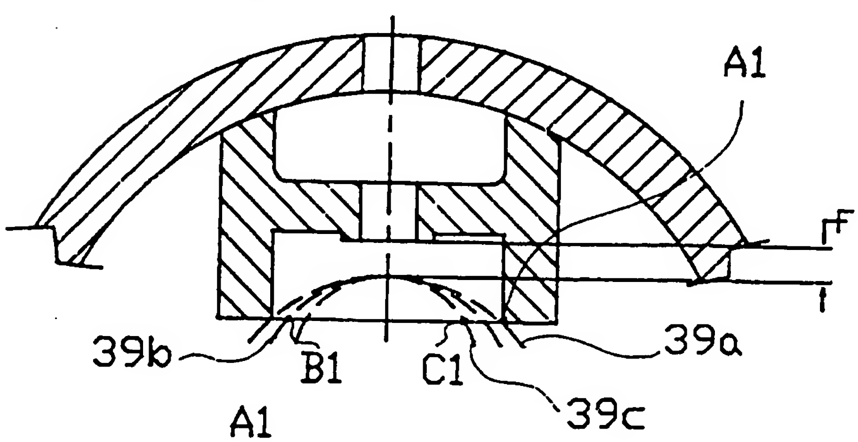

Fig:29e

Express Label No.
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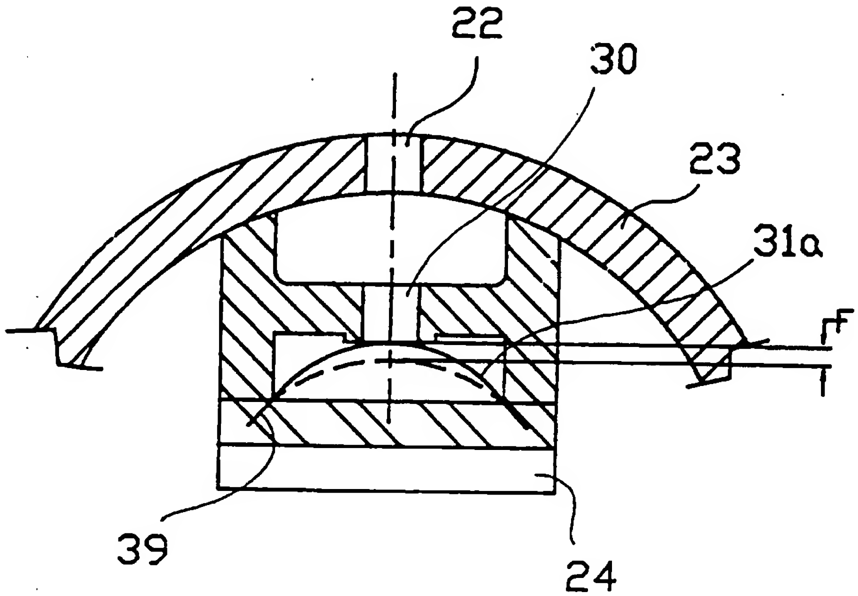

Fig:28b

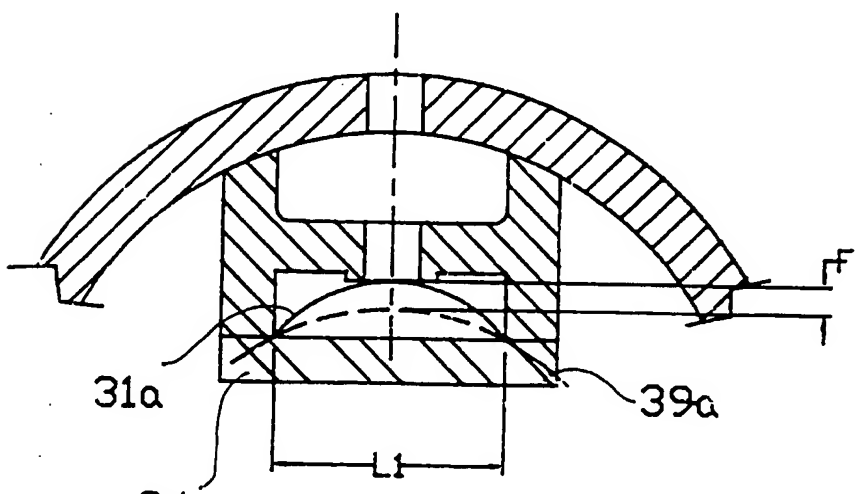

Fig:29b

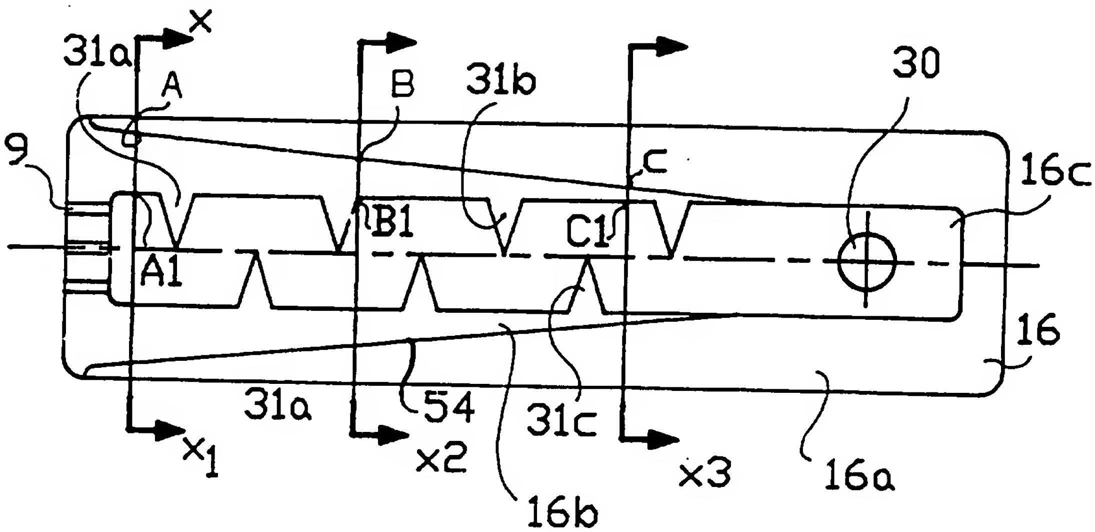

fig:30

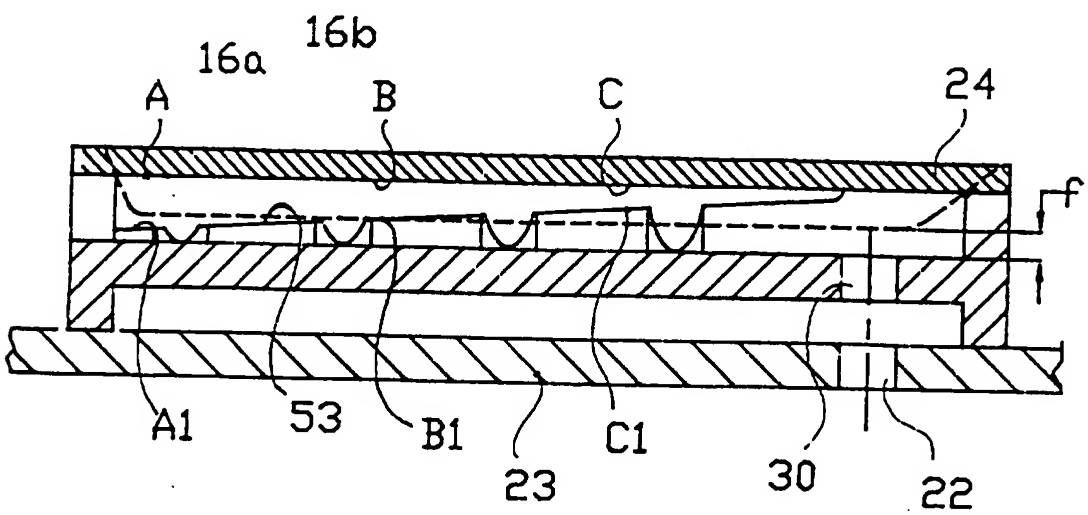

fig:30a

Express Label No.
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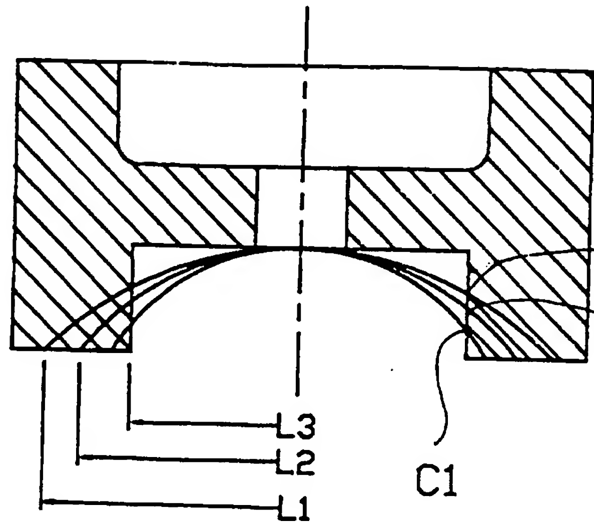

Fig:30b

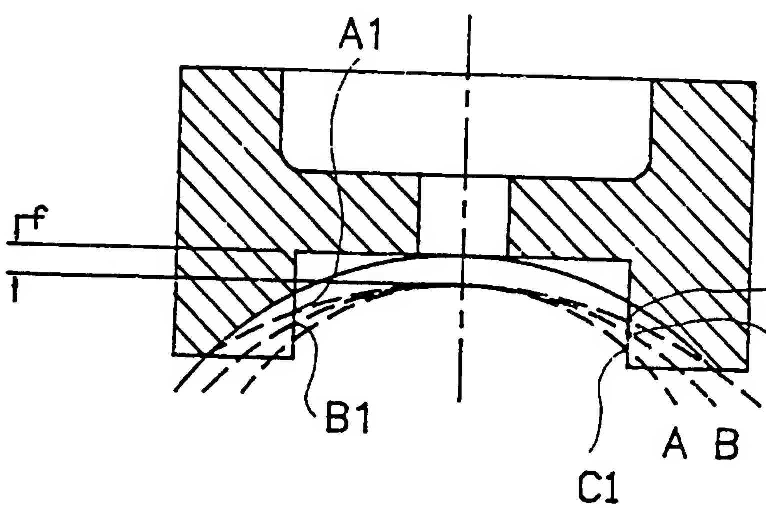

Fig:30C

Express Label No.
EV342539854US

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GR 96/00004

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 A01G25/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 A01G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US,A,4 008 853 (TREGILLUS) 22 February 1977 see column 2, line 65 - column 3, line 54; figures 1-6 ---	1
A	AU,B,633 097 (JAMES HARDIE BUILDING PRODUCTS) 21 January 1993 see page 5, line 8 - page 6, line 30; figures 1-5 ---	11
A	FR,A,2 500 259 (DUMONT) 27 August 1982 see page 4, line 40 - page 6, line 33 see page 8, line 15 - line 18; figures 1-4 ---	11
A	FR,A,2 625 544 (ROLLAND) 7 July 1989 see page 5, line 35 - page 8, line 20; figures 1-7 --- -/--	11,22, 37,38

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 May 1996	12. 06. 96

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	Herygers, J

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Express Label No.
EV342539854US

INTERNATIONAL SEARCH REPORT

national Application No
PCT/GR 96/00004

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US,A,3 777 980 (ALLPORT) 11 December 1973 see the whole document ---	36
A	EP,A,0 636 309 (COHEN) 1 February 1995 see column 3, line 34 - column 5, line 32; figures 1-5 -----	37,38

1

Express Label No.
EV342539854US

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GR 96/00004

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US-A-4008853	22-02-77	DE-A-	2648903	12-05-77
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		JP-A-	52079314	04-07-77
		NL-A-	7610862	03-05-77
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FR-A-2500259	27-08-82	AR-A-	225875	30-04-82
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		OA-A-	7004	31-08-83
		US-A-	4424936	10-01-84
FR-A-2625544	07-07-89	AU-B-	2766789	06-07-89
US-A-3777980	11-12-73	NONE		
EP-A-636309	01-02-95	US-A-	5400973	28-03-95
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		BR-A-	9402983	11-04-95
		CN-A-	1102939	31-05-95
		HU-A-	68481	28-06-95
		PL-A-	304482	06-02-95
		ZA-A-	9405626	07-03-95

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